# POWER

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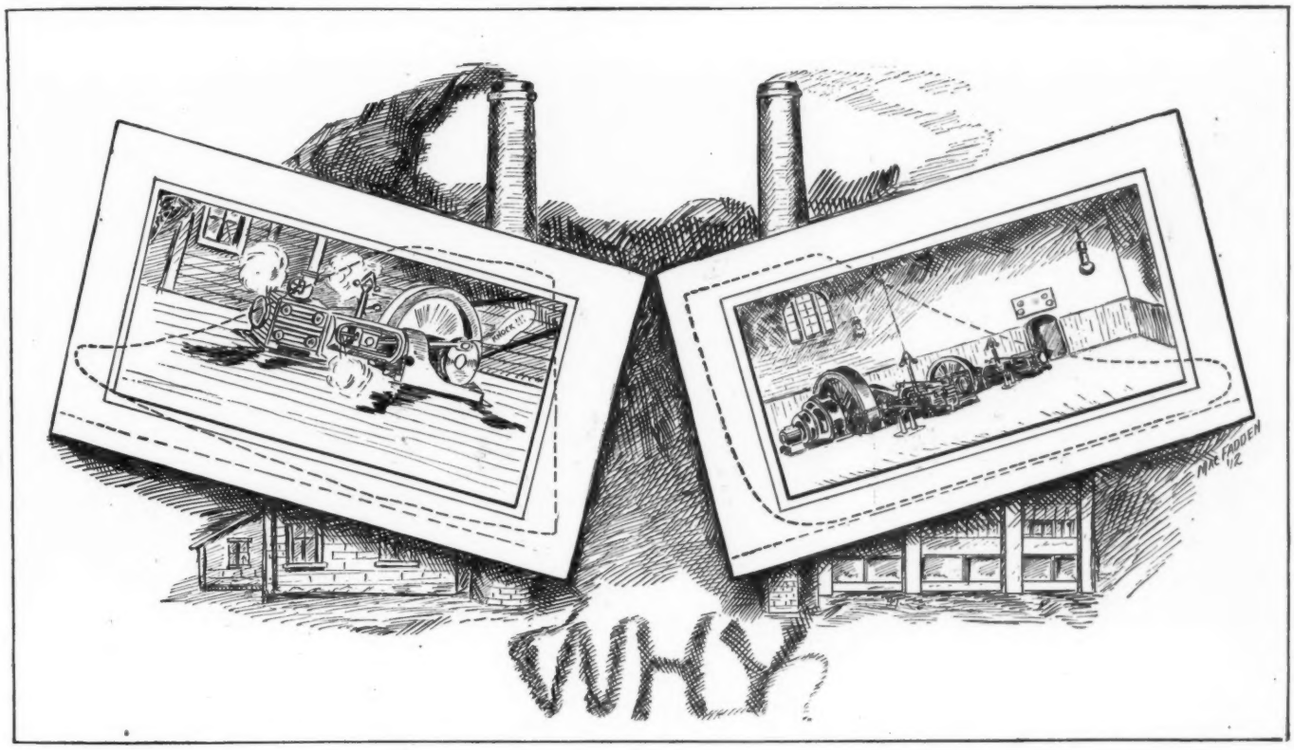
# A Study in Contrasts




[The above is more in the nature of a true cartoon than any we have yet printed, because the picture is complete in itself, needing no text to explain it. We wish we might have more as good.

Any who feel they cannot make drawings good enough for direct reproduction, may send rough sketches or even only descriptions of their "ideas" and accepted ones will be paid for in proportion.—EDITOR.]

# Plant of Landers, Frary & Clark Co.

By Warren O. Rogers

**A power plant in which many economical features have been incorporated. Upright hand-fired boilers and compound reciprocating engines comprise the main generating units.**

One of the interesting power plants in New Britain, Conn., is the new one recently completed by the Landers, Frary & Clark Co., manufacturers of silverware, etc.

### Boiler Room

Obtaining permission to visit the power plant, the writer found his way to the boiler room, where Chief Engineer Arthur H. Hill was superintending the washing out of several upright boilers, of which there are 11, each of 235 hp. capacity. As he had been caught working, something for which chief engineers are often not given credit, Mr. Hill explained that when his boilers are cleaned, he wants to personally know their condition, first, not second hand. "We hand-fire run-of-mine coal and handle the fires according to the quality of the fuel," said he.

"Usually the fires are run at a thickness of 10 in. They are not sliced during a run, but are shaken down occasionally. The fires, however, are leveled by evenly spreading the coal in light quantities, very rarely having to use the hoe, when the boilers are operating at their normal rating.

"The flue gases pass to the economizers at a temperature of 420 deg. F., leaving at 240 deg. F." Just then Mr. Hill was called to another part of the plant and the writer took the opportunity to investigate the boiler room.

Coal is delivered to the firemen from the yard supply in a 1½-ton car running on a commercial track, the rails of which are placed level with the brick floor. The track is made with a cross-over at the far end of the room which permits loaded cars being delivered to that end and empty cars run out at the near end. By this arrangement a supply of coal is always awaiting the firemen. The gases of combustion after passing through the two economizers go to a 225-ft. brick stack which creates a 1¼ in. draft.

A view of the piping in the boiler room is shown in Fig. 1. The main feed pipe runs along the front of each battery with globe valves in the vertical pipe leading to each individual boiler. There are two steam mains, one leading to the main generating units, the other supplying steam to the auxiliaries and also for factory use. The steam pressure is carried at 175 lb. The feed water passes through an open heater to this water weigher, it is then pumped through a closed heater and thence through the two economizers. All clean drips and the auxiliary turbine exhausts are returned to the open heater. Other exhaust steam passes through only the closed heater, and all oily drips are piped to the sewer.

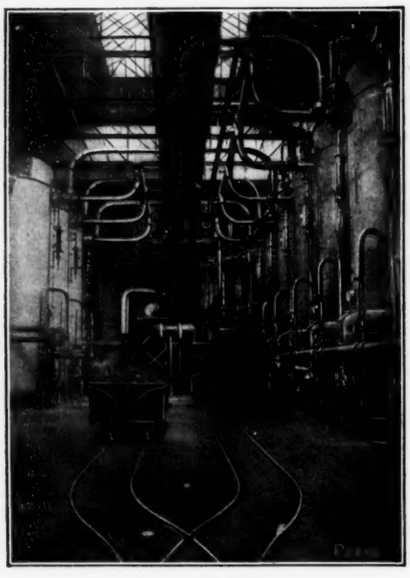


Fig. 1. Showing the Vertical Boilers and Car Tracks

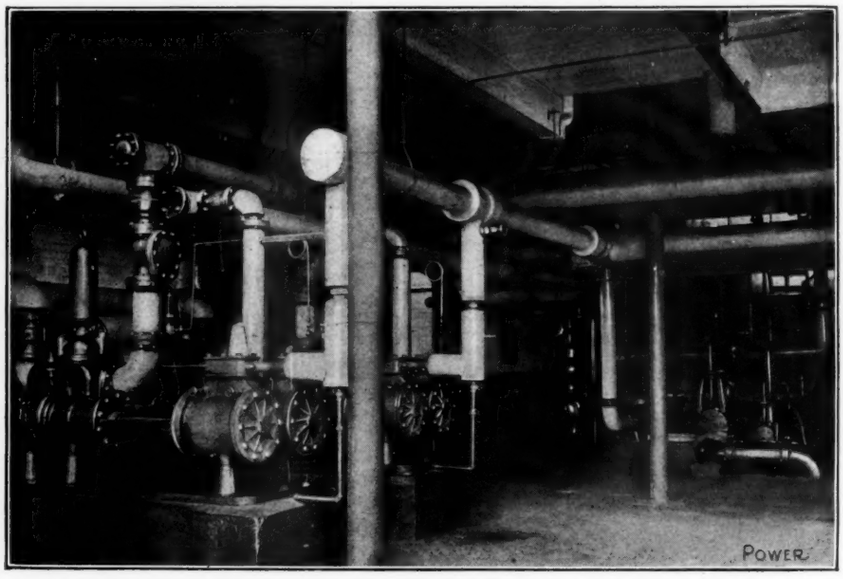



Fig. 2. One End of the Auxiliary Room

### Auxiliaries

In passing from the boiler room to the engine room, which is one story above the former, one passes through the pump room. There is sufficient room here because the entire basement outside of the engine foundation is given up to the auxiliary units, hence there has been no crowding. Fig. 2 shows a view of one side of the auxiliary room. There are two 12 and 7 by 12-in. boiler feed pumps, each mounted on a concrete base, bringing them to a convenient height for making repairs, etc.

The generating units are served by a twin vertical air pump and jet condenser, which maintains a vacuum of 27½ in. The condenser is set next to the head end of the engine foundation in the basement so that the connection between the engine and condenser is as short as it can be conveniently made. The condensing water is pumped from the hotwell through a cooling tower, having a capacity of 2170 gal. of water per minute and cooling from 120 to 90 deg., the atmospheric temperature being 70 deg. F. This water is handled by a turbine-driven 10-in. volute pump. The discharge is controlled by a poppet valve in the steam line, operated by a float in the hotwell.

### Engine Room

There are two main generating units, one with 24 and 48 by 48-in. cylinders, and one with 15¼ and 32½ by 22-in. cylinders. The larger cross-compound engine has a normal rating of 1550 hp. The smaller unit of 550 hp. is used as an auxiliary.

A motor-driven exciter-generator set of 60 kw. capacity, and a 75-hp. turbine-driven unit, used for the same purpose, are in an open space beside the smaller

main generating unit. The turbine runs at 6000 r.p.m., and is directly coupled to two 25-kw. direct-current generators running at 1500 r.p.m.

The factory lighting circuits are of 110 volts. The switchboard, located at one side of the engine room, is elevated as shown in Fig. 3. A gravity oil feed system is connected to the two engines, the supply tank of which is elevated. Returns from the engine bearings are filtered and pumped into the elevated supply tank.

The factory buildings are heated by a hot-water system, the water of which is heated by exhaust steam and in extreme cold weather by additional live steam. Circulation is obtained through a 60-hp. turbine-driven 10-in. centrifugal pump. There is also a motor-driven unit of the same size.

The engine-room floor is of concrete and the boiler-room and basement floors are brick; the entire plant is roomy and well lighted.

By the time the writer's inspection was well under way, Mr. Hill returned. The method of keeping power-plant data was discussed, which resulted in the writer obtaining a copy of the report sheet, shown in Fig. 4.

One feature of this report form is that all necessary information regarding

EQUIPMENT OF THE LANDERS, FRARY & CLARK POWER PLANT

| No. | Equipment | Make | Use | Kw. | Volts | Amp. | Phase | r.p.m. | Size | Pres. lb. | Hp. | Manufacturers |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 11 | Boilers | Bigelow-Manning | Steam generator | ... | ... | .. | .... | .. | .... | 175 | 235 | Bigelow Co. |
| 4 | Economizers | Sturtevant | Heating feed water | ... | ... | .. | .... | .. | .... | ... | .. | B. F. Sturtevant Co. |
| 1 | Heater | Open | Heating feed water | ... | ... | .. | .... | .. | .... | ... | .. | Hoppes Mfg. Co., |
| 1 | Heater | Closed | Heating feed water | ... | ... | .. | .... | .. | .... | ... | .. | Whitlock Coil Pipe Co. |
| 1 | Water weigher | Kennicott | Water meter | ... | ... | .. | .... | .. | .... | ... | .. | Kennicott Water Softener Co. |
| 2 | Duplex pumps | Outside packet | Boiler feed | ... | ... | .. | .... | .. | 12x7x12″ | 175 | .. | Blake Pump & Condenser Co. |
| 1 | Condenser | Jet | Main unit | ... | ... | .. | .... | .. | 20x36x21″ | 175 | .. | Blake Pump & Condenser Co. |
| 1 | Cooling tower | Wheeler | Cooling water | ... | ... | .. | .... | .. | .... | .... | .. | Wheeler Condenser & Engineering Co. |
| 1 | Turbine | Terry | Hot well pump | ... | ... | .. | .... | 4200 | .... | 175 | 40 | Terry Steam Turbine Co. |
| 1 | Pump | Volute | Hot well | ... | ... | .. | .... | 4200 | 10″ | 175 | .. | Worthington, Henry R. |
| 1 | Engine | McIntosh, Seymour | Main unit | ... | ... | .. | .... | 100 | 24x48x48″. | 175 | 1550 | McIntosh, Seymour & Co. |
| 1 | Engine | Phoenix | Main unit | ... | ... | .. | .... | 171 | 15¼x32½x22″ | 175 | 550 | Phoenix Iron Works Co. |
| 1 | Generator | Alternating current | Main unit | 800 | 550–600 | 1440 | 3 | 100 | .... | ... | .. | Crocker-Wheeler Co. |
| 1 | Generator | Alternating current | Main unit | 350 | 600 | 575 | 3 | 171 | .... | ... | .. | Crocker-Wheeler Co. |
| 1 | Motor | Induction | Exciter set | | 550 | 131 | 3 | 900 | .... | ... | 100 | Crocker-Wheeler Co. |
| 1 | Generator | Direct current | Exciter set | 60 | 125 | 480 | ... | 900 | .... | ... | .. | Crocker-Wheeler Co. |
| 1 | Turbine | De Laval | Exciter set | ... | ... | .. | .... | 6000 | .... | 175 | 75 | Le Laval Steam Turbine Co. |
| 2 | Generators | Direct current | Exciter set | 25 | 125 | 200 | .... | 1500 | .... | ... | .. | Crocker-Wheeler Co. |
| 2 | Filters | White star | Engine oil | ... | ... | .. | .... | ... | .... | ... | .. | Pittsburgh Gage & Supply Co. |
| 1 | Turbine | DeLaval | Heating system | ... | ... | .. | .... | .. | .... | 175 | 60 | Le Laval Steam Turbine Co. |
| 1 | Pump | Centrifugal | Heating system | ... | .... | .. | .... | .. | 10″ | ... | .. | Westinghouse Machine Co. |
| 1 | Motor | Induction | Heating system | ... | 550 | ... | 3 | 1140 | .... | ... | 60 | Westinghouse Electric & Mfg. Co. |
| 1 | Pump | Centrifugal | Heating system | ... | ... | .. | .... | .. | 10″ | ... | .. | Westinghouse Machine Co. |
| 1 | Stack | Brick | ..... | ... | ... | .. | .... | .. | 225′ | ... | .. | ..... |
| 1 | Heating system | Hot water | Factory | ... | ... | .. | .... | .. | .... | ... | .. | Evans-Almiral & Co. |
| 1 | Switchboard | Marble | Electrical control | ... | ... | .. | .... | .. | .... | ... | .. | Electrical & Mfg. Co. |

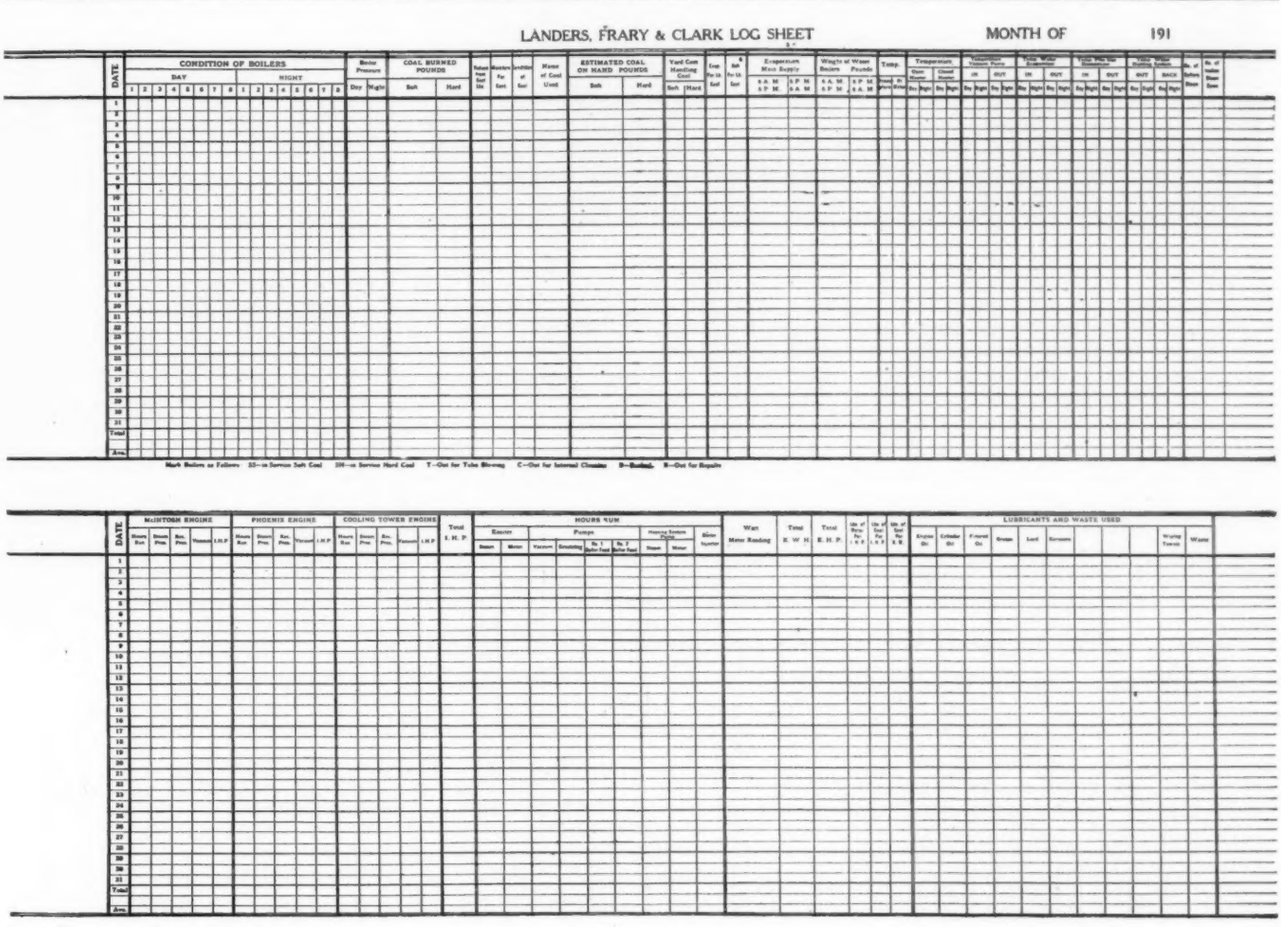



FIG. 4. FORM OF LOG SHEET USED AT THE PLANT

power-plant operation is confined to one sheet instead of a number of smaller ones. This enables obtaining all necessary data without looking over several reports and makes a very compact and satisfactory log.

The engineer or auditor can tell at a glance when variations in coal consumption appear, and if there is not a corresponding increase in the kilowatt-hour readings, it is seen that a leak is occurring at some point.

FIG. 3. PARTIAL VIEW OF THE ENGINE ROOM

Records are given of the hours the boilers and engines are in service, temperatures of the circulating water to and from the cooling tower, and the temperature of the feed water passing through the heater and economizer, as well as a list of the minor power-plant supplies used.

## A Simple Problem in Horsepower

BY WALLACE S. FOWLER

This subject is as familiar to every engineer as everyday arithmetic to the college man. Nevertheless, the same cause that has led many a technical graduate to dig out his textbook when suddenly confronted by a problem in cube root, might some day overtake the engineer who has been asked to compute the brake horsepower of a proposed engine and finds himself a little "rusty" in first principles. To be sure he might have a dozen catalogs of reliable concerns manufacturing engines, and yet fail to find in their tables just the conditions he is looking for. The following formulas and table may be of service in such a case:

$$B.hp. = \frac{m.e.p. \times L \times A \times 2N}{33{,}000} \times E \quad (1)$$

where

$B.hp.$ = Brake horsepower;
$m.e.p.$ = Mean effective pressure;
$L$ = Length of stroke in feet;
$A$ = Area of the cylinder (area of the rod neglected);
$N$ = Revolutions per minute;
$E$ = Mechanical efficiency of the engine.

The mean effective pressure may be obtained from the following simple formula:

$$m.e.p. = F\ (V - B.P.) \quad (2)$$

where

$F$ = Assumed card factor;
$V$ = Mean forward absolute pressure given in table;
$B.P.$ = Absolute back pressure in the exhaust pipe

*Example*: Required the brake horsepower of an engine with 16x18-in. cylinder, running at 250 r.p.m. under 150 lb. gage steam pressure, cutting off at one-third stroke; when the vacuum in the condenser is 27 in., the assumed card factor 80 per cent., and the assumed mechanical efficiency 90 per cent. For 150 lb. pressure and one-third cutoff $V$ from the table equals 115.21. The back pressure in the exhaust pipe includes the absolute pressure in the condenser (which is approximately one-half the difference between the given vacuum and perfect vacuum) plus an allowance for friction in the exhaust passages. In this problem assume the friction loss to be 2½ lb. Then the back pressure would equal

$$\frac{30 - 27}{2} + 2\tfrac{1}{2} = 4\ lb.\ absolute$$

Substituting in formula (2) gives

$$m.e.p. = 0.80\ (115.21 - 4) = 88.968 = 89$$

The area of a 16-in. cylinder is 201 sq.in. Then from formula (1)

$$B.hp. = \frac{89 \times 1.5 \times 201 \times 500 \times 0.90}{33{,}000} = 365.9$$

If the same engine were to operate noncondensing the back pressure would be 14.7 lb. abs. plus 2½ lb. friction, or 17.2 lb. abs., making

$$m.e.p. = 0.80\ (115.21 - 17.2) = 78.4\ lb.$$

and

$$B.hp. = \frac{78.4 \times 1.5 \times 201 \times 500 \times 0.90}{33{,}000} = 322$$

MEAN FORWARD ABSOLUTE PRESSURES CORRESPONDING TO DIFFERENT CUTOFFS

| Initial Pressure lb. gage | Cutoff in fractions of stroke | | | | | |
|---|---|---|---|---|---|---|
| | ¼ | ⅓ | ⅜ | ½ | ⅝ | ¾ |
| 15 | 17.72 | 20.77 | 22.05 | 25.14 | 27.28 | 28.70 |
| 20 | 20.70 | 24.27 | 25.76 | 29.37 | 31.88 | 33.53 |
| 25 | 23.68 | 27.77 | 29.47 | 33.61 | 36.47 | 38.36 |
| 30 | 26.67 | 31.27 | 33.18 | 37.84 | 41.06 | 43.19 |
| 35 | 29.65 | 34.76 | 36.89 | 42.07 | 45.66 | 48.02 |
| 40 | 32.63 | 38.26 | 40.60 | 46.30 | 50.25 | 52.86 |
| 45 | 35.61 | 41.76 | 44.31 | 50.54 | 54.85 | 57.69 |
| 50 | 38.60 | 45.26 | 48.03 | 54.77 | 59.44 | 62.52 |
| 55 | 41.58 | 48.76 | 51.74 | 59.00 | 64.03 | 67.35 |
| 60 | 44.56 | 52.25 | 55.45 | 63.23 | 68.63 | 72.18 |
| 65 | 47.55 | 55.75 | 59.16 | 67.47 | 73.22 | 77.01 |
| 70 | 50.53 | 59.25 | 62.87 | 71.70 | 77.81 | 81.85 |
| 75 | 53.51 | 62.74 | 66.58 | 75.93 | 82.41 | 86.68 |
| 80 | 56.50 | 66.24 | 70.30 | 80.16 | 87.00 | 91.51 |
| 85 | 59.48 | 69.74 | 74.01 | 84.40 | 91.59 | 96.34 |
| 90 | 62.46 | 73.24 | 77.72 | 88.63 | 96.19 | 101.17 |
| 95 | 65.44 | 76.73 | 81.43 | 92.86 | 100.78 | 106.00 |
| 100 | 68.43 | 80.23 | 85.14 | 97.09 | 105.37 | 110.83 |
| 105 | 71.41 | 83.73 | 88.85 | 101.33 | 109.97 | 115.67 |
| 110 | 74.39 | 87.23 | 92.56 | 105.56 | 114.56 | 120.50 |
| 115 | 77.37 | 90.72 | 96.28 | 109.79 | 119.15 | 125.33 |
| 120 | 80.36 | 94.22 | 99.99 | 114.02 | 123.75 | 130.16 |
| 125 | 83.34 | 97.72 | 103.70 | 118.26 | 128.34 | 134.99 |
| 130 | 86.32 | 101.22 | 107.41 | 122.49 | 132.94 | 139.82 |
| 135 | 89.31 | 104.71 | 111.12 | 126.72 | 137.53 | 144.66 |
| 140 | 92.29 | 108.21 | 114.83 | 130.95 | 142.12 | 149.49 |
| 145 | 95.27 | 111.71 | 118.55 | 135.19 | 146.72 | 154.32 |
| 150 | 98.25 | 115.21 | 122.26 | 139.42 | 151.31 | 159.15 |

All speed records for large ships have been lowered by the new British battle-cruiser "Princess Royal," which recently returned to Devonport on completing her experimental trials. She obtained a speed of 34 knots, or 39 miles an hour, which constitutes a world's record.

# Steam Power Plant Pipe Fittings

By William F. Fischer

**Information is given regarding the proper use of various weights and material of fittings for power plant piping.**

Cast-iron pipe should never be used for high-pressure steam mains because of its treacherous nature. It is extensively used for underground water and gas mains, sanitation piping, intake water mains, condenser work, etc. It is also used, to some extent, for high-pressure, boiler-feed mains, as it resists corrosion better than wrought-iron or steel pipe and is cheaper.

It should be of full, extra-heavy weight with extra-heavy flanges, and designed for a bursting pressure of not less than six times the greatest working pressure employed. If the working pressure is to be 200 lb. per sq.in., the pipe should not burst at less than 1200 lb. per sq.in., and a much larger factor of safety is desirable. A cast-iron feed pipe should be well supported throughout its length, because of its excessive weight, placing the pipe hangers or brackets about 12 ft. apart.

Cast-iron pipe of various weights and thicknesses may be had with flanged ends or bell and spigot ends. The latter are generally used for underground work, making a tight job when properly put together, calked and leaded. For exposed piping flanged ends are used and the joints made up with gaskets. When ordering cast-iron flanged pipe the working pressure should be stated, also the flange dimensions and drilling.

Table 1 gives the thickness and weights of cast-iron pipe of various sizes for working pressures of from 25 to 150 lb. per sq.in., or the equivalent hydraulic head as stated.

Table 2 gives the thickness and weights per foot of cast-iron pipe for the heavier pressures, up to 347 lb. per sq.in. The working pressure should always be specified, as the manufacturers' standard dimensions vary slightly.

The weights given in these tables do not include the weight of the flanges, but for estimating the weight of the two flanges on each piece of pipe may be taken as equivalent to the weight of a running foot of the pipe.

The following simple formulas may be used in calculating the pressures and thickness of cast-iron pipe:

Let

$W$ = Safe working pressure in lb. per sq.in.;

$P$ = Average bursting pressure in lb. per sq.in.;

$D$ = Inside diameter of pipe in in.,

$t$ = Thickness of metal in in.;

$F$ = Factor of safety ($P \div W$);

$f$ = Unit fiber stress in pipe material in lb. per sq.in.

Then, based on an ultimate tensile strength of 20,000 lb. for cast iron,

$$P = \frac{40{,}000\,t}{D} \qquad (1)$$

$$W = \frac{40{,}000\,t}{DF} \qquad (2)$$

$$t = \frac{WDF}{40{,}000} \qquad (3)$$

$$f = \frac{WD}{2\,t} \qquad (4)$$

The following examples illustrate the use of the formulas:

At what pressure will a piece of 7-in. cast-iron pipe 0.6 in. thick, burst?

Using formula 1,

$$P = \frac{40{,}000\,t}{D} = \frac{40{,}000 \times 0.6}{7} =$$

3429 *lb. per sq.in. nearly.*

In Table 1 this pipe is recommended for a working pressure of 150 lb. per sq.in.; then the factor of safety will be,

$$F = \frac{3429}{150} = 22.8 +$$

With a factor of safety ($F = 10$), what would be the safe-working pressure ($W$) of a 7-in. pipe 0.6 in. thick?

From Formula 2,

$$W = \frac{40{,}000\,t}{DF} = \frac{40{,}000 \times 0.6}{7 \times 10} =$$

343 *lb. per sq.in.*

For a working pressure $W = 343$ lb. and a factor of safety of 10, what thickness of metal would be required for a 7-in. pipe?

Using Formula 3,

$$t = \frac{WDF}{40{,}000} = \frac{343 \times 7 \times 10}{40{,}000} = 0.6\ in.$$

Under a working pressure of 343 lb. per sq.in., what would be the unit fiber stress in the metal of a 7-in. cast-iron pipe of 0.6 in. thickness?

From Formula 4,

$$f = \frac{WD}{2\,t} = \frac{343 \times 7}{2 \times 0.6} = 2000\ lb.\ per\ sq.\ in.$$

Cast-iron pipe is regularly made in 12-ft. lengths, and always thicker than necessary to withstand the intended pressures, so as to safely resist all stresses and shocks likely to occur in transit, in handling and in erecting.

### Riveted Steel Pipe

Riveted steel pipe is made up of straight or spiral riveted plates; the first is known as straight-riveted; the latter as spiral-riveted pipe. They are furnished with either pressed- or forged-steel flanges riveted to the ends. The latter are preferable, being heavier and stronger. Such pipe is usually galvanized to prevent corrosion and to make the riveted joints tighter after calking. It is used extensively in noncondensing power-plant work for exhaust-steam mains, suction mains, large drains, etc., but should never be used for live steam, feed water or similar high-pressure work. It may be had in lengths up to 20 ft.

Spiral-riveted pipe, because of its construction, is stronger than straight-riveted pipe of equal size, thickness and quality. The single seam in spiral-riveted pipe being continuous, and helical from end to end of the pipe, stiffens it throughout its length.

*TABLE I. THICKNESS AND WEIGHTS OF CAST IRON PIPE

| Inside Diameter in Inches | Thickness in Inches | | | | Approximate Weight per Foot, in Pounds. (Weight of Flanges not included.) | | | |
|---|---|---|---|---|---|---|---|---|
| | 60 Ft. Head 25 Lbs. Pressure | 115 Ft. Head 50 Lbs. Pressure | 230 Ft. Head 100 Lbs. Pressure | 350 Ft. Head 150 Lbs. Pressure | 60 Ft. Head 25 Lbs. Pressure | 115 Ft. Head 50 Lbs. Pressure | 230 Ft. Head 100 Lbs. Pressure | 350 Ft. Head 150 Lbs. Pressure |
| 3 | 0.39 | 0.41 | 0.43 | 0.45 | 13.0 | 13.7 | 14.5 | 15.2 |
| 4 | 0.40 | 0.43 | 0.46 | 0.49 | 17.3 | 18.7 | 20.1 | 21.6 |
| *5 | 0.42 | 0.46 | 0.49 | 0.53 | 22.3 | 24.7 | 26.4 | 28.7 |
| 6 | 0.44 | 0.48 | 0.52 | 0.56 | 27.8 | 30.5 | 33.3 | 36.0 |
| *7 | 0.46 | 0.52 | 0.56 | 0.60 | 33.7 | 38.3 | 41.5 | 44.7 |
| 8 | 0.47 | 0.53 | 0.59 | 0.64 | 39.0 | 44.3 | 49.7 | 54.2 |
| *9 | 0.49 | 0.55 | 0.62 | 0.68 | 45.6 | 51.5 | 58.5 | 64.5 |
| 10 | 0.51 | 0.58 | 0.65 | 0.71 | 52.5 | 60.2 | 67.9 | 74.5 |
| 12 | 0.54 | 0.63 | 0.71 | 0.79 | 66.4 | 78.0 | 88.5 | 99.0 |
| 14 | 0.58 | 0.66 | 0.77 | 0.86 | 82.9 | 94.9 | 111.5 | 125.3 |
| *15 | 0.60 | 0.70 | 0.80 | 0.90 | 91.8 | 107.7 | 123.9 | 140.3 |
| 16 | 0.61 | 0.72 | 0.84 | 0.95 | 99.3 | 118.0 | 138.7 | 157.9 |
| 18 | 0.65 | 0.77 | 0.90 | 1.02 | 118.8 | 141.7 | 166.7 | 190.2 |
| 20 | 0.67 | 0.82 | 0.96 | 1.09 | 135.8 | 167.4 | 197.3 | 225.0 |
| 22 | 0.72 | 0.87 | 1.02 | 1.18 | 160.4 | 195.0 | 230.2 | 268.1 |
| 24 | 0.75 | 0.92 | 1.08 | 1.25 | 182.0 | 224.7 | 265.5 | 309.4 |
| 30 | 0.86 | 1.07 | 1.28 | 1.48 | 260.2 | 325.9 | 392.5 | 456.7 |
| 36 | 0.96 | 1.21 | 1.46 | 1.71 | 347.8 | 442.3 | 536.1 | 632.0 |
| 40 | 1.03 | 1.31 | 1.59 | 1.87 | 414.2 | 530.4 | 648.2 | 767.5 |
| 42 | 1.07 | 1.36 | 1.65 | 1.93 | 451.7 | 578.0 | 705.9 | 835.5 |
| 48 | 1.18 | 1.51 | 1.84 | 2.17 | 568.8 | 732.8 | 898.9 | 1067.1 |

Note 5, 7, 9 and 15 inch pipe are odd sizes, made to order only
4" inch to 24 inch regularly made in 12 ft. lengths faced $\frac{1}{16}$ inch short for gasket.
*From R. D. Wood & Co. Catalogue.

In Table 3 is given the bursting pressure in pounds per square inch for spiral-riveted pipe of various sizes and thicknesses. The safe working pressure employed should never exceed 25 per cent. of the bursting pressure as listed in the table; in other words, a factor of safety

$$P = \frac{120{,}000\ t\ e}{D} \quad (5)$$

$$W = \frac{120{,}000\ t\ e}{DF} \quad (6)$$

$$t = \frac{W\,DF}{120{,}000\ e} \quad (7)$$

*TABLE II. THICKNESS AND WEIGHTS OF CAST IRON PIPE FOR HIGH PRESSURE SERVICE

| Inside Diameter, Inches | Thickness of Metal in Inches | | | | | Approximate Weight per Foot, in Pounds | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | 400 Ft Head | 500 Ft. Head | 600 Ft. Head | 700 Ft. Head | 800 Ft. Head | 400 Ft. Head | 500 Ft. Head | 600 Ft. Head | 700 Ft. Head | 800 Ft. Head |
| | 173 Lb. Pressure | 217 Lb. Pressure | 260 Lb. Pressure | 304 Lb. Pressure | 347 Lb. Pressure | 173 Lb. Pressure | 217 Lb. Pressure | 260 Lb. Pressure | 304 Lb. Pressure | 347 Lb. Pressure |
| 6 | 0.55 | 0.58 | 0.61 | 0.65 | 0.69 | 38.3 | 41.7 | 43.3 | 47.1 | 49.6 |
| 8 | 0.60 | 0.66 | 0.71 | 0.75 | 0.80 | 55.8 | 61.7 | 65.7 | 70.8 | 75.0 |
| 10 | 0.68 | 0.74 | 0.80 | 0.86 | 0.92 | 76.7 | 86.3 | 92.1 | 100.9 | 106.7 |
| 12 | 0.75 | 0.82 | 0.89 | 0.97 | 1.04 | 100.0 | 113.8 | 122.1 | 135.4 | 143.8 |
| 14 | 0.82 | 0.90 | 0.99 | 1.07 | 1.16 | 129.2 | 145.0 | 157.5 | 174.2 | 186.7 |
| 16 | 0.89 | 0.98 | 1.08 | 1.18 | 1.27 | 158.3 | 179.6 | 195.4 | 219.2 | 232.5 |
| 18 | 0.96 | 1.07 | 1.17 | 1.28 | 1.39 | 191.7 | 220.4 | 238.4 | 267.1 | 286.7 |
| 20 | 1.03 | 1.15 | 1.27 | 1.39 | 1.51 | 229.2 | 263.0 | 286.3 | 320.8 | 344.6 |
| 24 | 1.16 | 1.31 | 1.45 | | | 306.7 | 359.6 | 392.9 | | |
| 30 | 1.37 | 1.55 | 1.73 | | | 450.0 | 521.7 | 585.4 | | |
| 36 | 1.58 | 1.80 | 2.02 | | | 625.0 | 725.0 | 820.0 | | |

*From U. S. Cast Iron Pipe & Foundry Co.

of not less than four should be used, and then only when the pressure is practically uniform.

For pumping mains and similar piping where the pressure is apt to increase suddenly, or where shocks from water-hammer are probable, a larger factor of safety should be employed, not less than 6 or 8, depending upon the conditions. To find the safe-working pressure in pounds per square inch from the table, divide the given bursting pressure by the factor of safety. When ordering riveted pipe the gage or thickness of metal should always be specified.

Where

$P$ = Approximate bursting pressure in lb. per sq.in.;
$W$ = Safe working pressure in lb. per sq.in.;
$D$ = Inside diameter of pipe in in.;
$t$ = Thickness of metal in in.;
$F$ = Factor of safety = $P \div W$;
$e$ = Efficiency of riveted joint in per cent.

*TABLE III. THICKNESS AND BURSTING PRESSURES OF SPIRAL RIVETED STEEL PIPE

| Inside Diameter, Inches | Thickness, U. S. Standard Guage | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | 20 | 18 | 16 | 14 | 12 | 10 | 8 | 6 | 3 |
| | Approximate Bursting Pressure, Pounds per Sq. Inch | | | | | | | | |
| 3 | 1500 | 2000 | | | | | | | |
| 4 | 1125 | 1500 | 1875 | | | | | | |
| 5 | 900 | 1200 | 1500 | | | | | | |
| 6 | | 1000 | 1250 | 1560 | 2170 | | | | |
| 7 | | 860 | 1070 | 1340 | 1860 | | | | |
| 8 | | 750 | 935 | 1170 | 1640 | | | | |
| 9 | | | 835 | 1045 | 1460 | | | | |
| 10 | | | 750 | 935 | 1310 | | | | |
| 11 | | | 680 | 850 | 1200 | | | | |
| 12 | | | 625 | 780 | 1080 | 1410 | | | |
| 13 | | | 575 | 720 | 1010 | 1295 | | | |
| 14 | | | 535 | 670 | 940 | 1210 | | | |
| 15 | | | | 625 | 875 | 1125 | | | |
| 16 | | | | 585 | 820 | 1050 | 1290 | 1520 | 1880 |
| 18 | | | | 520 | 730 | 940 | 1140 | 1360 | 1660 |
| 20 | | | | 470 | 660 | 840 | 1030 | 1220 | 1500 |
| 22 | | | | 425 | 595 | 765 | 940 | 1108 | 1364 |
| 24 | | | | 390 | 540 | 705 | 820 | 1015 | 1250 |
| 26 | | | | | 505 | 650 | 795 | 935 | 1154 |
| 28 | | | | | 470 | 605 | 735 | 870 | 1071 |
| 30 | | | | | 435 | 560 | 685 | 810 | 1000 |
| 32 | | | | | 410 | 525 | 645 | 760 | 940 |
| 34 | | | | | 380 | 490 | 600 | 715 | 880 |
| 36 | | | | | 365 | 470 | 570 | 680 | 830 |
| 40 | | | | | 330 | 420 | 515 | 610 | 750 |
| | Approx. Thickness in Decimal Parts of an Inch | | | | | | | | |
| | 0.0375 | 0.05 | 0.0625 | 0.078 | 0.109 | 0.141 | 0.172 | 0.203 | 0.25 |

*(American Sprial Pipe Works.) (Condensed from Catalogue.)

The following formulas may be used in calculating the pressure and thickness of riveted steel pipe:

The tensile strength of the steel plate varies from about 50,000 to 70,000 lb. per sq.in. The foregoing formulas are based on an average ultimate tensile strength of 60,000 lb. per sq.in. for steel plates. The efficiency of riveted joints in straight-riveted pipe varies from 50 to 85 per cent; average 70 per cent.

### Brass and Copper Pipes

Brass pipe for power-plant work should be made to the same dimensions as wrought-iron and steel pipe, and threaded to the wrought-iron standard. When ordering brass pipe, iron pipe size should always be specified; otherwise the manufacturer might supply the lighter weight, thin-brass tubing, commonly used for ornamental work, brass hand railings, etc.; it is not of the proper size to take the standard pipe thread and is too thin for pressure work.

Brass pipe is more expensive than wrought-iron or steel pipe and is seldom used in large sizes, but in the small sizes is used for connecting boiler gages, feed-water connections between the feed main and boilers and also for hot-water service in general. It is not subject to corrosion. The average ultimate tensile strength is about 18,000 lb. per sq.in., or about one-third that of mild steel pipe of equal dimensions.

Copper pipe is seldom, if ever, used for power-plant work, except in the very small sizes, such as oil and lubricator piping, etc. It is very unreliable for high steam pressures, and deteriorates very rapidly under high temperatures and repeated stresses. At a temperature of 360 deg. F. its strength is reduced 15 per cent. and on this account it should never be used in steam power-plant work for high pressures or temperatures.

## Effect of Boiler Scale

Tests and experiments made by the engineering department of the University of Illinois show the possibilities of heat loss from mineral incrustations inside of boilers varying in thickness from $^1/_{50}$ to $^1/_{16}$ in. The tests brought out the following results:

| Character of Scale | Thickness | Composition | Loss |
|---|---|---|---|
| Hard | $\frac{1}{50}$ in. | Mostly carbonates | 9.4 per cent. |
| Soft | $\frac{1}{32}$ in. | Mostly carbonates | 7.2 per cent. |
| Hard | $\frac{1}{32}$ in. | Mostly carbonates | 8.5 per cent. |
| Soft | $\frac{1}{25}$ in. | Mostly carbonates | 8.0 per cent. |
| Hard | $\frac{1}{25}$ in. | Mostly sulphate | 9.3 per cent. |
| Hard | $\frac{1}{20}$ in. | Mostly sulphate | 11.1 per cent. |
| Soft | $\frac{1}{16}$ in. | Mostly sulphate | 10.8 per cent. |
| Soft | $\frac{1}{16}$ in. | Mostly carbonates | 11.0 per cent. |
| Soft | $\frac{1}{16}$ in. | Mostly carbonates | 12.4 per cent. |

This table illustrates how good evaporative results may be handicapped not only 12 per cent., but even more by allowing incrustations to increase beyond the $\frac{1}{16}$-in. thickness.

Farmers near Fort Wayne, Ind., are supplied with electricity by the central station at that point at the rate of 10c. per kilowatt-hour. The customer is obliged to furnish his own transformer, meter and all other equipment and pay a minimum of $2 per month meter charge.—*Gas Review.*

# Spontaneous Heating of Stored Coal

**The loss by escape of volatile matter has been greatly overestimated and reduction of heat value from weathering is small.**

**Storage under fresh or salt water to save calorific value is not justified but may prevent spontaneous combustion.**

**Causes of spontaneous combustion and how to prevent it in storing coal.**

Owing to the many requests for exact information on the deterioration and spontaneous heating of coal, the Bureau of Mines has published a preliminary paper by Horace C. Porter and F. K. Ovitz, giving a summary of the results thus far obtained. An abstract of this paper follows:

A study was made of the loss of volatile matter from crushed coal during storage. The coal tested was in 20-lb. samples and represented a variety of kinds from widely separated fields. Each sample was broken to about half-inch size at the mine, placed as quickly as possible in a large glass bottle and shipped to the laboratory. At the laboratory the accumulated gas was withdrawn and the volatile products were permitted to escape freely and continuously at atmospheric pressure and temperature. The results of these experiments have been published in a technical paper of the Bureau of Mines, and will not be given here in detail. Suffice it to say that, although several coals evolve methane in large volumes, especially shortly after mining, the coals tested lost in one year from this cause only 0.16 per cent. at most of their calorific value. It seems, therefore, that the loss caused by escape of volatile matter from coal has been greatly overestimated.

At the instance of the Navy Department more elaborate tests were undertaken to determine the total loss possible in high-grade coal by weathering. The extent of the saving to be accomplished by water submergence as compared with open-air storage was to be settled, as was also the question whether salt water possessed any peculiar advantage or disadvantage over fresh water for this purpose.

## Outline of Tests

In brief, the tests by the bureau were carried out as follows: Four kinds of coal were chosen—New River, W. Va., on account of its large use by the Navy; Pocahontas, Va., from its wide use as a steaming and coking coal in the Eastern states, and the principal fuel used in the Panama Canal work; Pittsburgh coal, as a rich coking and gas coal, and Sheridan, Wyo., sub-bituminous coal or "black lignite," as a type much used in the West.

In the tests with the New River coal, 50-lb. portions were made up out of one large lot, which had been crushed to quarter-inch size and well mixed, and portions, confined in perforated wooden boxes, were submerged under sea water at three navy yards that differed widely from one another in climatic conditions. Portions of 300 lb. each from the same original lot were exposed to the open air, both outdoors and indoors, at the same navy yards.

The Pocahontas coal was tested at only one point, the Isthmus of Panama, where run-of-mine coal was placed in a 120-ton pile exposed to the weather. Pittsburgh coal was stored as run-of-mine at Ann Arbor, Mich., both in open 5-ton bins outdoors and in 300-lb. barrels submerged in fresh water. The Wyoming sub-bituminous coal was stored at Sheridan, Wyo., both as run-of-mine and slack, in outdoor bins that held 3 to 6 tons each.

Duplicate samples were taken at each sampling, and the sampling of every lot, except the outdoor pile at Panama and the 300-lb. open-air piles at the navy yards, was done by rehandling all the coal. In the excepted cases it was not thought fair to disturb the entire lot. Therefore at Panama a vertical section of the pile, weighing 10 tons, was removed each time; eight gross samples were taken from this 10-ton portion, and each of the samples was quartered down. From the outdoor piles at the navy yards a number of small portions were taken from well distributed points in each pile, mixed, and quartered down. Small lots, finely divided, were purposely chosen with the New River coal, to make the tests most severe.

A fact the authors emphasize is that physical deterioration of the coal was not tested, such as increase of friability, or slacking of lumps. Consequently the results do not show how the relative availability of heat units may have been affected by physical changes; but they do show how much the calorific value, as determined in the laboratory, was affected by storage of the coal under the several conditions.

CALORIFIC VALUE (IN GRAM CALORIES) OF THE COAL SUBSTANCE (MOISTURE, ASH AND SULPHUR FREE COAL) BEFORE AND AFTER STORAGE

| Kind of Coal | Storage Conditions | Place | Calorific Value | | | | |
|---|---|---|---|---|---|---|---|
| | | | As Stored | After 3 Months | After 1 Year | After 2 Years | Percentage of Loss in 2 Years |
| New River, W. Va. *a* | ¼-inch coal, under sea water. | Portsmouth, N.H. | 8761 | ..... | 8759 | 8730 | *b* 0.39 |
| | | Norfolk, Va. | 8754 | ..... | 8763 | 8737 | *b* 0.40 |
| | | Key West, Fla. | 8747 | ..... | 8732 | 8770 | 0 |
| | ¼-inch coal, under fresh water. | Pittsburgh, Penn. | 8752 | 8762 | 8749 | 8760 | 0 |
| | ¼-inch coal, exposed to air indoors. | Portsmouth, N.H. | 8779 | 8738 | 8742 | 8709 | 0.80 |
| | | Norfolk, Va. | 8751 | 8742 | 8736 | 8717 | 0.39 |
| | | Key West, Fla. | 8754 | 8728 | 8676 | ..... | ..... |
| | | Pittsburgh, Penn. | 8769 | 8736 | 8719 | 8720 | 0.56 |
| | R. o. m. coal, exposed to air indoors. | Portsmouth, N.H. | 8754 | 8758 | 8748 | 8734 | 0.23 |
| | | Norflok, Va. | 8743 | 8764 | 8725 | 8725 | 0.21 |
| | | Key West, Fla. | 8745 | 8733 | 8710 | ..... | ..... |
| | | Pittsburgh, Penn. | 8753 | 8758 | 8740 | 8743 | 0.11 |
| | ¼-inch coal, exposed to air outdoors, uncovered. | Portsmouth, N.H. | 8741 | 8730 | 8701 | 8674 | 0.77 |
| | | Norfolk, Va. | 8726 | 8709 | 8666 | 8625 | 1.16 |
| | | Key West, Fla. | 8739 | 8721 | 8680 | 8592 | 1.85 |
| | | Pittsburgh, Penn. | 8763 | 8726 | 8700 | 8665 | 1.12 |
| | R. o. m. coal, exposed to air outdoors, uncovered. | Portsmouth, N.H. | 8775 | 8766 | 8760 | 8722 | 0.60 |
| | | Norfolk, Va. | 8743 | 8745 | 8720 | 8695 | 0.55 |
| | | Key West, Fla. | 8752 | 8708 | 8722 | 8632 | 1.29 |
| | | Pittsburgh, Penn. | 8752 | 8740 | 8716 | 8696 | 0.64 |
| Pocahontas, Va. | 120-ton pile, r.o.m. coal, outdoors. | Panama | 8794 | 8787 | 8762 | ..... | ..... |
| Pittsburgh bed. | 4 tons r.o.m. coal in open bin, outdoors. | Ann Arbor, Mich. | 8541 | *c* 8539 | 8526 | ..... | ..... |
| | | | 8541 | *d* 8553 | 8528 | ..... | ..... |
| Sheridan, Wyo., sub-bituminous *c* | R.o.m., open bin 5 ft. deep. | Sheridan, Wyo. | 7370 | 7174 | ..... | 7135 | *f* 3.19 |
| | R. o. m., closed bin 5 ft. deep. | Sheridan, Wyo. | 7370 | 7202 | ..... | 7094 | *f* 3.75 |
| | R. o. m. closed bin 15 ft. deep. | Sheridan, Wyo. | 7370 | 7303 | ..... | 6982 | *f* 5.26 |
| | Slack, closed bin 15 ft. deep. | Sheridan, Wyo. | 7355 | 7166 | ..... | 6990 | *f* 4.96 |

*a* Heating value of representative mine sample of coal (ash, moisture and sulphur free), 8768 calories. *b* On basis of original heating value of same test portion. *c* After six months' storage, entire lot in bin. *d* After six months' storage, upper 6 inches at surface of bin. *e* Each bin contained 5 to 10 tons. *f* After two years and three-quarters.

## Results of Tests

The accompanying table is a condensed summary of results from a large number of tests and determinations. The moisture, ash, and sulphur contents and

the calorific value of each sample were determined. To eliminate the effect of incidental impurities that were not concerned in the deterioration of the actual coal substance, the calorific values are calculated to moisture, ash, and sulphur free bases, and the ash as determined is corrected for errors due to oxidation of pyrites and dehydration of shale or clay.

The New River coal showed less than 1 per cent. loss of calorific value in one year by weathering in the open. In two years the greatest loss was at Key West, 1.85 per cent. Practically nothing was lost by the submerged samples in one year, fresh or salt water serving equally well to "preserve the virtues" of the coal. There was almost no slacking of lumps in the run-of-mine samples. In all tests the crushed coal deteriorated more rapidly than the run-of-mine.

The Pocahontas run-of-mine coal in a 120-ton pile on the Isthmus of Panama lost during one year's outdoor weathering less than 0.4 per cent. of its heating value, and showed little slacking of lumps.

Gas coal during one year's outdoor exposure suffered practically no loss of calorific value, measurable by the calorimetric method used, not even in the coal forming the top 6-in. layer in the bins.

The Wyoming coal in one of the bins deteriorated in heat value 5.3 per cent. during storage for two and three-fourths years, and more than 2.5 per cent. in the first three months. There was bad slacking and crumbling of the lumps on the surface of the piles, but even where this surface was fully exposed to the weather the slacking did not penetrate more than 12 to 18 in. in the 2¾-year period.

No outdoor weathering tests of coal of the Illinois kind have been made by the Bureau of Mines, but tests of such coal have been reported by Prof. S. W. Parr, of the University of Illinois, and by A. Bement, of Chicago, both of whom find a calorific loss of 1 to 3 per cent. in a year by weathering. Bement reports a slacking of lumps over 80 per cent. in one test and of about 12 per cent. in another test of small samples. Possibly with the Illinois as with the Wyoming coal, the slacking in a large pile would not penetrate far from the surface.

Storage under water unquestionably preserves the heating value and the physical strength of coal, but such storage practically makes necessary the firing of wet coal, and consequently the evaporation in the furnace of added moisture varying in amount from 1 to 15 per cent. according to the kind of coal. This is an important drawback to underwater storage of coals like the Illinois and Wyoming, which mechanically retain 5 to 15 per cent. of water after draining. High-grade Eastern coals, however, are ordinarily wet down before firing; hence the 2 or 3 per cent. of moisture these coals absorb during storage becomes of little consequence. Submerged storage absolutely prevents spontaneous combustion, and that alone may justify it when the coal is particularly dangerous to store and when large quantities are to be stored; but unless the coal is to be stored longer than one year, storing under water merely to save calorific value by avoiding weathering seems unjustified.

## Spontaneous Combustion

Losses of value from spontaneous heating are much more serious than the deterioration of coal at ordinary temperatures. Oxidation proceeds more rapidly as the temperature rises. Beginning at ordinary temperatures, attacking surfaces of particles, and developing heat, it is probably, in some degree, an absorption of oxygen by the unsaturated chemical compounds in the coal substance. In a small coal pile this slowly developed heat can be readily dissipated by convection and radiation and very little rise in temperature results. If the dissipation of the heat is restricted, however, as in a large pile densely packed, the temperature within the pile rises continuously. The rate of oxidation plotted against the temperature makes a curve that rises very rapidly. When the storage conditions allow warming of the coal to about 212 deg. F., the rate of oxidation becomes so great that the heat developed in a given time ordinarily exceeds the heat dissipated, and the temperature rises until, if the air supply is adequate, the coal takes fire. Evidently, therefore, it is important to guard against even moderate heating of the coal, either spontaneous or from an external source. Increased loss of volatile matter and of heating value occurs with a moderate rise of temperature, even though the ignition point is not reached.

Spontaneous combustion is brought about by slow oxidation in an air supply sufficient to support oxidation, but insufficient to carry away all the heat formed. The area of surface exposed to oxidation by a given mass of any one coal determines largely the amount of oxidation that takes place in the mass; it depends on the size of the particles and increases rapidly as the fineness approaches that of dust. Dust is therefore dangerous, particularly if mixed with lump coal of such size that the interstices permit the flow of a moderate amount of air to the interior. Coals differ widely in friability, that is, in the proportion of dust produced under like conditions. In comparative tests samples of Pocahontas, New River and Cambria County, Penn., coals produced nearly twice as much dust (coal through a ⅛-in. screen) as coal mined from the Pittsburgh bed in Allegheny County, Penn. This variation in friability affects the tendency to spontaneous heating.

Ideal conditions for such heating are offered by a mixture of lump and fine coal, such as run-of-mine with a large percentage of dust, in piles where a small supply of air reaches the interior.

## Effect of Volatile Matter

High volatile matter does not of itself increase the tendency to spontaneous heating. A letter of inquiry sent by the bureau to more than 2000 large coal consumers in the United States brought 1200 replies. Of these, 260 reported instances of spontaneous combustion and 220 of the 260 gave the name of the coal. The 220 instances were distributed as follows: Ninety-five were in semibituminous low-volatile coals of the Appalachian region, 70 in higher-volatile coals of the same region, and 55 in Western and Middle Western coals. This shows at least no falling behind of the "smokeless" type of coal in furnishing instances of spontaneous combustion, and no cause for placing special confidence in this class of coal for safety in storage.

The high-volatile coals of the West are usually very subject to spontaneous heating, but owe it to the chemical nature of their constituents rather than to the amount of volatile matter they contain. Strange as it may seem, the oxygen content of coal appears to bear a direct relation to the avidity with which coal absorbs oxygen; high-oxygen coals absorb readily, and therefore have a marked tendency to spontaneous combustion.

## Effect of Moisture and of Sulphur

The effects of moisture and sulphur on spontaneous heating have been much discussed with wide difference of opinion. Little experimental evidence has been brought to bear on either question, and neither is yet settled. Richters has shown that in the laboratory dry coal oxidizes more rapidly than moist; but most practical users of coal believe that moisture promotes spontaneous heating. In none of the many cases of spontaneous combustion observed by the authors could it be proved that moisture had been a factor. Still the physical effects of moisture on fine coal, such as closer packing together of dust or small pieces may often aid spontaneous heating.

In certain laboratory experiments, where air was passed over samples of coal heated to 248 deg. F., enough heat developed to almost ignite the coal; the coal was then allowed to cool. Subsequent analysis showed practically no increase in the sulphate, or oxidized form of sulphur, and practically no reduction of the total sulphur in the coal. Though the results of these experiments are not entirely conclusive, they indicate that sulphur content contributes very little to the spontaneous heating of coal.

### Importance of Freshly Exposed Surfaces

Freshly mined coal and the fresh surfaces exposed by crushing lumps exhibit marked avidity for oxygen, but after a time the surfaces become oxidized, "seasoned," as it were, retarding further action of the air. In practice, coal that has been stored for six or eight weeks and has even become already somewhat heated, if rehandled and thoroughly cooled by the air, seldom heats spontaneously again.

### Suggestions in Storing Coal

With full appreciation that any or all of the following suggested precautions may prove impracticable or unreasonably expensive under certain conditions, they are offered as advisable for safety in storing bituminous coal.

1. Do not pile over 12 ft. deep, nor so that any point in the interior of a pile will be over 10 ft. from an air-cooled surface.
2. If possible, store only screened lump coal.
3. Keep out dust as much as possible; to this end reduce handling to a minimum.
4. Pile so that the lump and fine are distributed as evenly as possible; not, as is often done, allowing lumps to roll down from the peak and form air passages at the bottom of the pile.
5. Rehandle and screen after two months, if practicable.
6. Do not store near external sources of heat, even though the heat transmitted be moderate.
7. Allow six weeks' "seasoning" after mining and before storing.
8. Avoid alternate wetting and drying.
9. Avoid admitting air to the interior of a pile through interstices around foreign objects, such as timbers or irregular brickwork, or through porous bottoms, such as coarse cinders.
10. Do not try to ventilate by pipes, or more harm may often be done than good.

## Artificial Coal Experiments in Germany

At the annual meeting of the Association of German Chemists, Dr. Bergius, of Hanover, read a paper on his experiments on the manufacture of artificial coal. He heated cellulose, or peat, with water, to a temperature of 340 deg. C., at a pressure of over 100 atmospheres, in a specially constructed apparatus. Both these substances were transformed into a product physically and chemically identical to coal.

At a temperature of 310 deg. C., the process took 60 hours, and at 340 deg. C., the transformation took place in eight hours. The speed of the reaction is doubled with every additional 10 deg. C. of temperature.

Dr. Bergius estimates on this basis that the time necessary for the formation of natural coal, at the temperature of the earth's crust, is 8,000,000 years, a figure approximating that given by geology.

## The Wells Variable Speed Power Transmission Device

Speed-reducing gears of the various kinds, belts and cone pulleys, and other speed-changing devices, are open to the objections that fine adjustment of speed is not possible and time is wasted in shutting down to change from one speed ratio to another, not to mention the wear and tear and shock caused by the process.

Frank T. Wells, 1156 First National Bank Building, Chicago, Ill., has designed and applied for patent on a variable-speed power-transmission device which is intended to overcome these objections.

In Fig. 1, showing longitudinal and cross-sections, the transmission disk *A* is loosely mounted on shaft *B* and rigidly keyed to the driven shaft *C*. This disk contains eight cylinders *D* divided into sets of four. The cylinders of each set are connected together by the passages *E*. Working from the cranks *F*, which are integral with the driving shaft but disconnected from the driven, are the pistons *G*. The variable space in the cylinders *D* and passages *E* is filled with oil, glycerin, or some other low-volatile fluid of low viscosity and high lubricating quality. The valves *H* control the flow of the fluid from one cylinder to another. With the valves wide open there is only slight resistance to the flow of the fluid and practically no torsional force is transmitted from the driving shaft to the driven. With the valves partly or fully closed there is resistance to the free action of the pistons and hence some force is transmitted from one shaft to the other. Thus by regulating the valves any ratio of speed may be established between the two shafts, positively, gradually and without shock or jar.

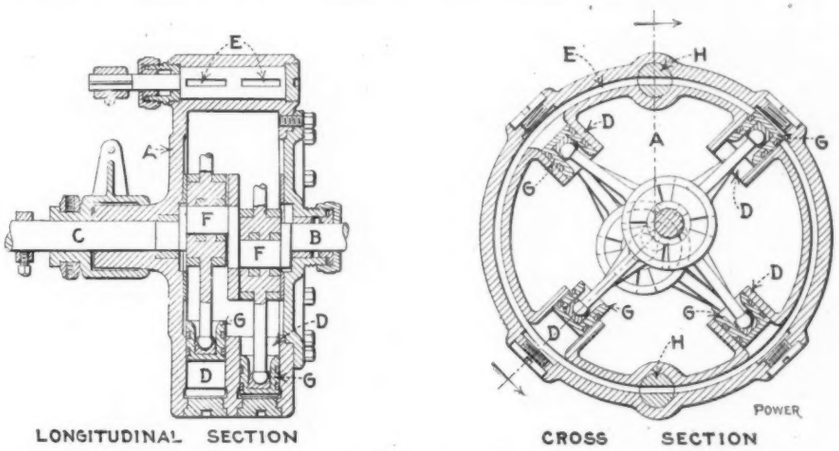



Fig. 1. Sectional Views of the Wells Variable-speed Power Transmission Device.

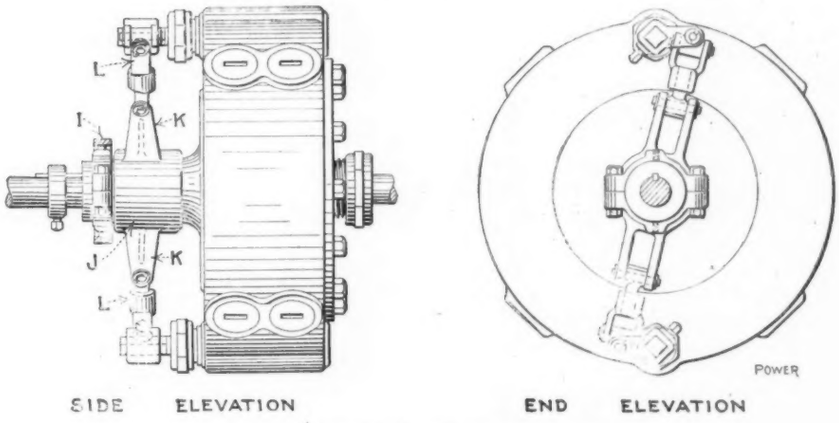



Fig. 2. Exterior Views of the Device

The valves are controlled by a lever, not shown, and the loose collar *I*, Fig. 2, which is attached to the sleeve *J*. By shifting the sleeve *J* along the shaft to the left, the arms *K* and links *L* cause the valves to close. Thus the speed of the driven shaft is regulated simply by shifting the hand lever much or little, according to the speed desired.

# Thermometers for the Steam Plant

By J. C. Peebles

**Some special thermometers and their receptacles for water and steam lines, condenser, economizer and flue gas temperatures.**

In its simplest form the thermometer consists of a glass stem containing a fine capillary tube with a comparatively large bulb at the lower end. The bulb and part of the stem are filled with mercury, the expansion and contraction of which in the bulb, due to changes in temperature, cause its level in the tube to rise or fall. A temperature scale engraved on the glass stem makes it possible to read the temperature for any particular height of the mercury in the tube.

Many modifications of this comparatively simple instrument have been devised, so that the mercury thermometer may be applied to a variety of uses for which the simple glass stem is not well adapted. Some of the special forms for use in the steam plant, and with which the operating engineer should be familiar, will be given attention.

Thermometers are used on the boiler feed-water line, condenser and economizer; on steam lines, particularly for superheated steam; in breeching, uptake or stack for flue-gas temperatures, and for various other purposes where an accurate knowledge of temperature is desired.

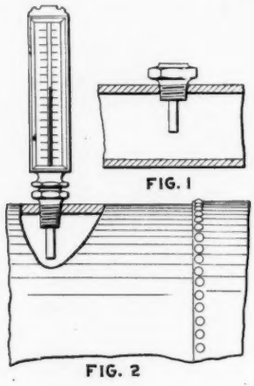


FIG. 1

FIG. 2

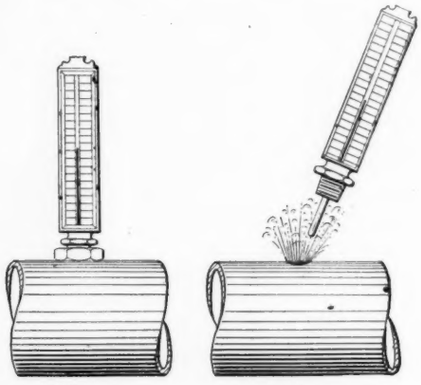


FIG. 3 FIG. 4

The first step in the evolution of these special thermometers was the provision of a receptacle into which the simple glass-stem thermometer could be put, when it was desired to find the temperature in pipe lines, etc. Fig. 1 shows a form of special receptacle which is merely a plug with a wrench head at the top and a standard pipe thread below, usually 1 in. in diameter, drilled to receive the thermometer. The hole is partly filled with oil or mercury, except for high temperatures, 600 deg. F. and above, when fine steel filings or precipitated copper is used; the material in the well serves to make contact between the instrument and the wall of the receptacle.

Such an arrangement works well in pipe lines carrying water, brine or low-pressure saturated steam. For lines carrying air or high-pressure superheated steam, the results are not so good, owing to the imperfect nature of the contact between the thermometer and the medium whose temperature is sought. Furthermore, the thermometer is easily broken in such a position, the well becomes filled with dirt, and the mercury or oil distills or evaporates after a time so that the arrangement is unsatisfactory for permanent use.

Fig. 2 shows the next step, the mounting of the thermometer in a metal case, with a fitting at the bottom to screw into the oil well, the well being threaded on the inside to receive it. Instead of the fixed thread shown here, however, a union is better to make the connection, as shown by Fig. 3, so that the thermometer may be screwed home with the scale facing in any direction. This gives a good permanent connection; chances for breakage are minimized, and dirt cannot get into the well. The contact is no better than before; hence the application of the thermometer has not been materially widened. To improve the contact, an attempt was made to do away with the oil well, and connect the thermometer directly to the pipe, by means of its screw connection. This answers fairly well for permanent connections, but the pipe line must be cut out of service if the thermometer is taken out. From Fig. 4 it is evident that this is such a serious objection to this arrangement that it has never had a wide application.

The problem, then, is to produce a thermometer for use in pipe lines, tanks, etc., which shall come quickly and accurately to the temperature of the medium into which it is placed, shall be removable without putting the pipe or tank out of service, shall be free from corrosive action by hot gases, and reasonably proof against mechanical injury. Such a thermometer is shown in Fig. 5, and Fig. 6 shows the bulb end in enlarged section. In Fig. 6 *A* is the thermometer, *B* a thin-walled metal chamber containing a bath of mercury or fine steel filings *C* inclosing the thermometer bulb, *D* a screw to compress the packing in the stuffing-box *E* to hold the thermometer tube in alignment, *F* insulating material to prevent the conduction of heat along the stem, *G* a threaded fitting for attaching the thermometer to its socket and *H* a hexagon wrench head.

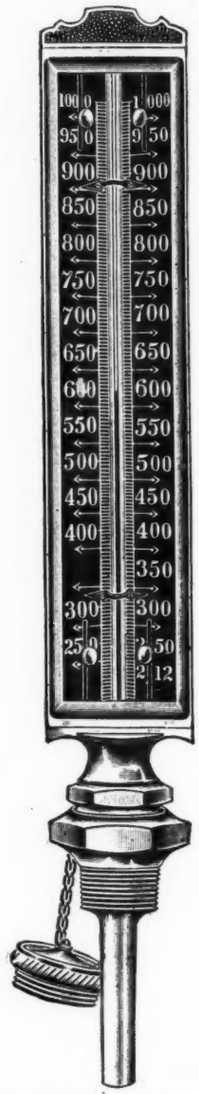



FIG. 5. SPECIAL THERMOMETER FOR PIPE LINES, TANKS, ETC.

Standard sockets of various lengths are made to receive this thermometer, and

are attached permanently to the pipe line. Some of these are shown in Fig. 7. When the thermometer is screwed home, its metal-protecting bulb fits snugly against the inner wall of the socket, giving a direct metallic contact from the outside of the socket to the bulb of the thermometer. This arrangement is not an oil well, for the socket contains no oil, but provides rather for a direct contact. Furthermore, the contact surfaces are made tapering to insure the best possible fit.

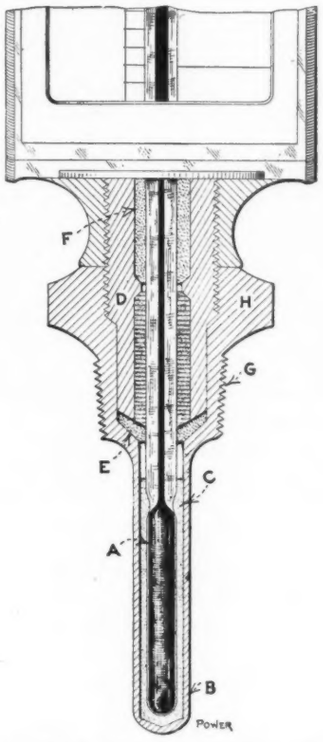



FIG. 6. BULB END OF FIG. 5 IN SECTION

The sockets shown in Fig. 7 are of bronze or steel, and are sometimes coated with lead or other substances best suited to the conditions of use to prevent corrosion. Each has a screw cap attached with a chain; thus the socket is protected from dirt when the thermometer is removed.

One interesting application of this thermometer is as a thermo-steam gage. It can be made with two scales, one for temperature and one for pressure, in which form it constitutes one of the most reliable steam-pressure gages known. In fact, the thermometer has many points of superiority over the Bourdon gage as an indicator of saturated-steam pressures, one of the most important being that it has no moving parts and therefore cannot get out of adjustment.

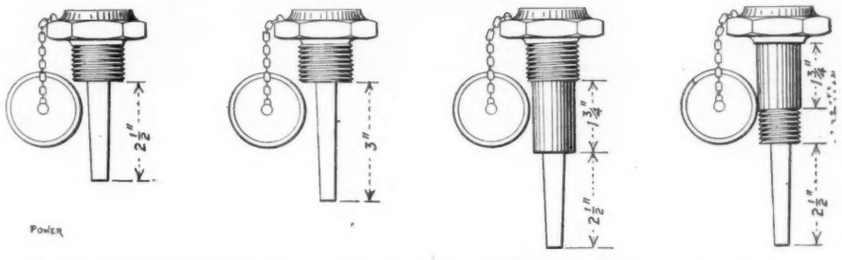



FIG. 7. STANDARD SOCKETS FOR ATTACHING PERMANENTLY TO PIPE LINE

Determining flue-gas temperatures, which is now recognized as important, requires a slightly different thermometer. Fig. 8 shows such an instrument and Fig. 9 the bulb end in section. The construction is similar to that of the pipe-line thermometer, except that no socket is used. The lower end of the instrument is surrounded with a heavy steel wire guard, which allows the hot gases to come directly in contact with the outer metal bulb *H*, but protects it from mechanical injury.

Flue gases at a comparatively high temperature are rather difficult to accurately measure. This is true also of air, superheated steam and many other gases, and is due to the poor contact which the gas offers to the thermometer bulb, because gases are poor heat conductors. To meet this difficulty the thermometer shown in Fig. 9 is sometimes made without the metal-protecting bulb *H* and mercury bath *C*. To protect the bulb, it is electroplated with copper, which is a good heat conductor. This produces a highly sensitive instrument which comes quickly to the temperature of the surrounding medium and is less subject to injury than one with an unprotected bulb.

One interesting instrument which has a variety of applications, is the maximum and minimum thermometer shown in Fig. 10. It is made in several different forms, one of the most serviceable being mounted in a cylindrical brass case less than 2-in. in diameter. In this shape it may be used in dry kilns, ship holds or coal bunkers to give temperature readings in inaccessible places. Stored coal generates heat through the decomposition of sulphur and iron which lowers the heat value and may cause spontaneous combustion. Through a gas pipe driven into the coal pile, a cylindrical maximum-minimum thermometer may be lowered, and the temperature accurately recorded.

This instrument has a double or U-shaped mercury tube, the left limb of which has the low temperatures at the top, while on the right side the high temperatures are at the top. Above the mercury, in each limb of the tube, is a small indicator or float, which is simply a very small piece of glass tubing sealed at both ends, and having a piece of fine steel wire run through the bore from end to end. A tiny spring made from a fiber of blown glass is attached to the indicator with its free end bearing against the inner wall of the mercury tube. When the mercury rises, the little indicator is carried up in the tube, and when it falls

FIG. 8. FOR FLUE GAS TEMPERATURES

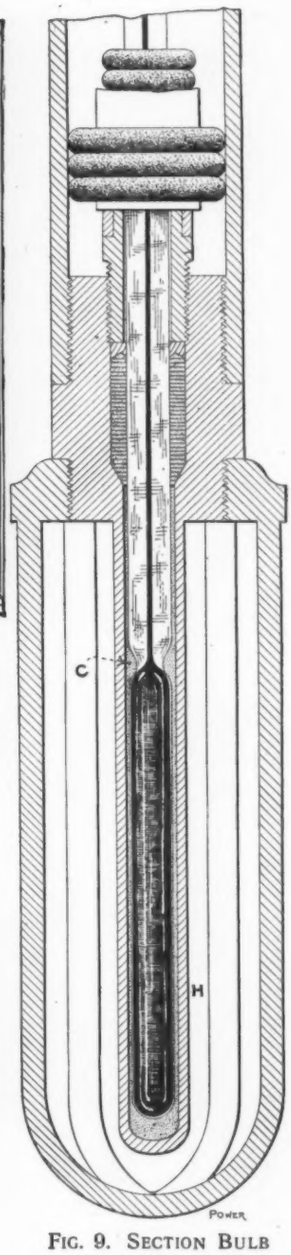



FIG. 9. SECTION BULB END OF FIG. 8

the indicator remains at the highest position reached, being held there by the little glass spring. The indicator may be drawn down again by a horseshoe magnet. The part of the tube between the two limbs of the capillary is enlarged into a long bulb and filled with creosote. When the creosote expands the mercury is forced down in the left-hand tube and up in the other. When it contracts the reverse takes place. The bulb at the top of the right capillary is filled with an oil having a low coefficient of expansion as compared with creosote.

Practically all of the simple glass thermometers on the market are pointed and calibrated under a condition of full

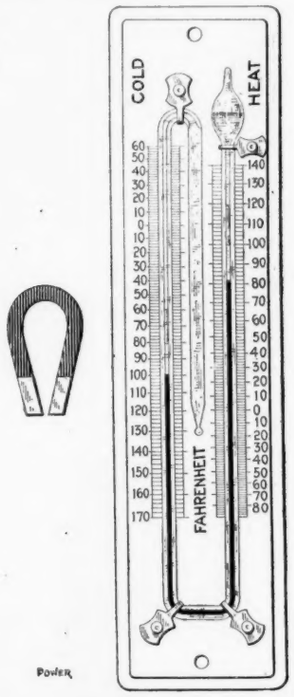



FIG. 10. MAXIMUM AND MINIMUM THERMOMETER

stem immersion. Often, as for flash and fire test of an oil, little more than the bulb is immersed. A thermometer calibrated for full stem immersion will give erroneous results when used with bulb immersion only, the readings being as much as 20 to 30 deg. low at a temperature of 600 deg. F. This has led to the production of a special thermometer having two scales on the stem, one to be used when the bulb only is immersed, and the other when the full stem is immersed. Thus the instrument becomes applicable to either condition of use. Perhaps the only objection which can be made to such a thermometer is the chance for confusion which arises when two scales are used.

When a thermometer is to be used under conditions which give bulb immersion only, it is probably better to use an instrument calibrated for that condition. Thermometers can now be obtained on the market which are correct for bulb immersion or for 1-in., 2-in. or 3-in. immersion as may be desired. A mark is etched on the stem at the point to which it must be immersed to give correct results. This does away with the confusion arising from two scales, although such a thermometer does not have as wide a range of usefulness as the one with the double scale.

The special thermometers discussed here, except the maximum-minimum type, should all be calibrated for bulb immersion, as that is the condition under which they are used.

## Curbs around Floor Openings

BY A. E. DIXON

A power-plant building must have floors or platforms pierced more or less for stair hatches, pipe openings, etc. Occasionally these openings are temporary, to be closed or occupied by later installations of apparatus. Other openings have seats for cast-iron floor slabs. In these days of concrete and steel a few kinks in regard to finishing off around these openings may not be generally known.

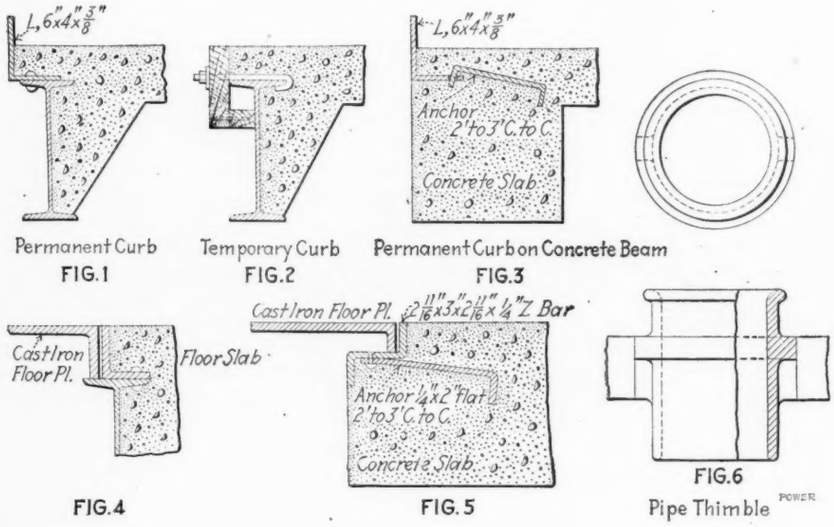
Fig. 1 is a curb designed for railed openings. The projection of the angle above the floor level is to prevent wash water or tools from going over the edge. A curb of this kind is suitable around stairway hatches. When desired the upstanding leg of the angle can be made equal to the thickness of the floor.

Fig. 2 shows a temporary wooden curb which is level with the floor but can be made higher if necessary.

Fig. 3 shows a curb for use with concrete beam or slab floors. Concrete is particularly subject to damage at corners; hence some sort of metal-protecting piece is needed. A further advantage of the metal-curb angle is that it affords a point of attachment for the railing.

Figs. 4 and 5 show curbs for openings which are to be closed up with removable floor plates, Fig. 4 being intended for steel beams with concrete floor slabs, while Fig. 5 shows a construction for use where concrete framing is used. If desired an angle can be substituted for the Z-bar, but the latter is preferable as it gives thorough protection to the concrete.

Fig. 6 shows a cast-iron pipe thimble for setting in a concrete slab. Thimbles of this kind should be large enough to permit the pipe flange to pass through, with some allowance for pipe covering. The projection above the floor prevents sweepings or wash water from going through the opening. Two lugs at opposite sides prevent the thimble from turning and working loose while the collar at the floor level serves to anchor it. Such thimbles may be set in the forms, if they are carefully located to suit the pipes and well watched to prevent their being forced out of place when the concrete is put in.




## Goulds New Vertical Centrifugal Pump

A new pump has been added to the line of centrifugal pumps developed by the Goulds Manufacturing Co., Seneca Falls, N. Y. It is of the vertical type, for service where it is necessary to pump from a pit, and can be operated submerged when desirable.

The impeller is of the inclosed type, and the end thrust is practically negligible. A ball-thrust bearing carries the weight of the impeller and shaft. A water-sealing ring is provided, making it unnecessary to draw the shaft gland up tight and insuring low friction losses.

For special liquids which attack iron this pump can be brass fitted or made entirely of brass. It can be belt driven or directly connected to an electric motor.

# Electrical Department

Conducted to be of service to the men in charge of electrical equipment in the power house

## Old and Modern Arc Switchboards

The progress made during the past 20 years in electrical practice as regards switchboard construction is strikingly shown in the accompanying photographs. Fig. 1 is a view of the high-tension arc switchboard used in the Rockwell Place station of the Brooklyn Edison Co. in 1895, and Figs. 2 and 3 show one of the latest arc switchboards located in the Sumpter St. substation of that company.

The old switchboard was constructed mainly of wood and carried direct current at 2500 volts, supplied by a number of old-style Thomson & Houston arc machines. As will be seen from the illustration, the circuits were closed by inserting plugs to which were attached the insulated leads. The switchboard was handled without rubber gloves, and as the circuits were changed while alive, a considerable arc usually resulted when withdrawing a plug. It is easily conceivable that the constant handling would tend to deteriorate the insulation, especially where the lead joined the plug, thus making it dangerous for the operator and greatly increasing the fire hazard. In addition to this the network of wires at the front of the switchboard tended to complicate its handling and confuse the operator in an emergency.

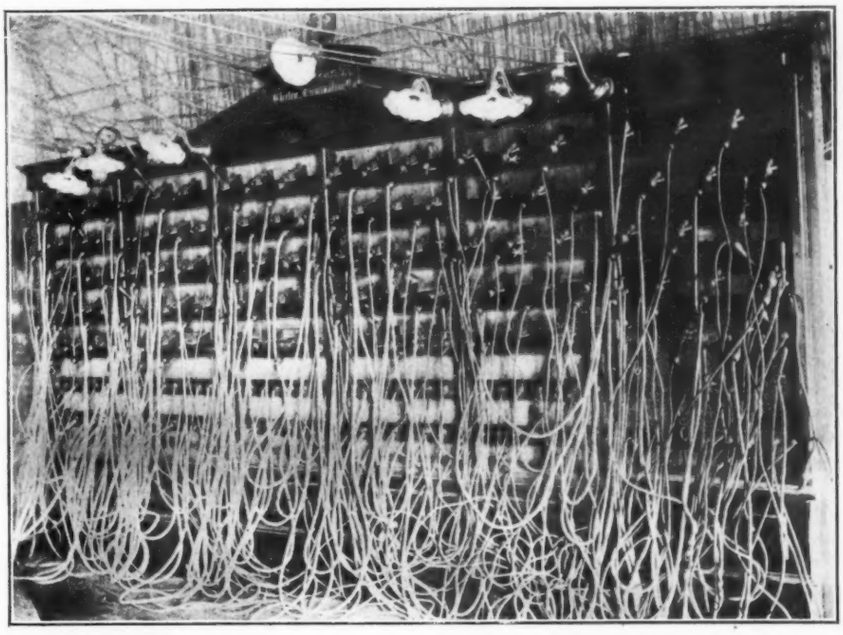


FIG. 1. ARC SWITCHBOARD AT ROCKWELL PLACE STATION, 1895

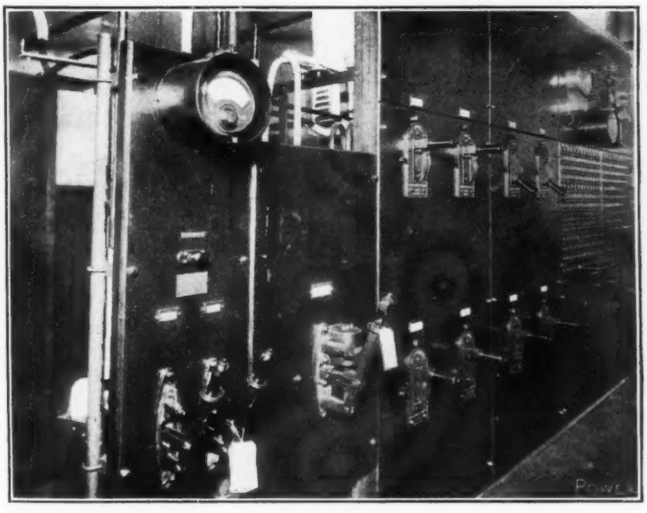


FIG. 2. ALTERNATING-CURRENT PANELS AND ARC-CIRCUIT PANELS

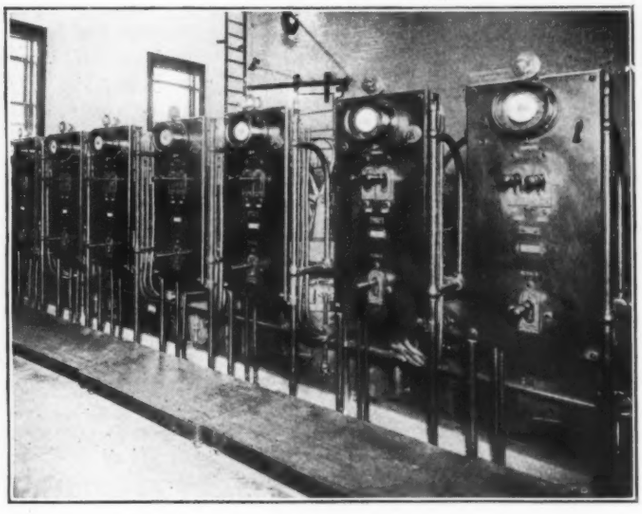


FIG. 3. RECTIFIER PANELS

In strong contrast to this is the modern arc panels. Here the 6600-volt, single-phase alternating current comes in to the oil switches mounted on the panels in the foreground of Fig. 2, passing from here to the rectifiers. The 7500-volt direct current coming from the rectifiers is led to the panels shown in Fig. 3; each rectifier has its own panel containing an ammeter, oil switches, bulb-tilting handle and indicating lamp.

From these panels the current is led to the horizontal busbars at the back of the two panels shown in the background of Fig. 2—one panel for the positive and one for the negative side of the circuit. To the vertical busbars (also not shown) are connected the arc-lighting circuits. Thus by inserting plugs in the receptacles any combination can be had; that is, any circuit can be thrown on any rectifier, or *vice versa*. Also, there is a row of receptacles for detecting grounds and two for instruments. The board has a capacity of 10 circuits and 10 rectifiers, each rectifier having a capacity of 75 lamps.

## Why Dynamos Fail to Generate

By J. T. Williams

Among the many causes which make a dynamo fail to generate, loss of residual magnetism is one of the most troublesome. The magnetism that remains in the iron cover after the field current is cut off is called residual magnetism, and every dynamo must have a certain amount of this, before it can build up its field.

As a rule dynamos leaving the factory retain enough residual magnetism to start on, but there are several ways in which they can lose it. They sometimes lose it after having given no previous trouble of that nature in years. Some dynamos never lose their residual magnetism, while others seem to have a weakness for doing so. In many cases this peculiar action cannot be explained, but in some cases it may be due to excessive vibration and for this reason the machine should always rest on a firm foundation. Also the earth's magnetism may exercise a slight influence, and it may be well to set the machine so that its north pole is toward the north, in which case the earth's magnetism will pass through the machine in the same direction as its own. The earth's magnetism is very weak, but when assisted by vibration it is sometimes sufficient to affect the residual magnetism. Only two-pole machines can be set to fill this condition, as the poles on multipolar machines radiate in all directions.

Again, lines of force from a loaded dynamo may tread their way through the magnetic circuit of an idle machine in the reverse direction and neutralize its residual magnetism. The fields may accidentally get a slight flow of current in the wrong direction. This can very easily occur on a compound-wound or series dynamo, as current from the outside will always pass through the series coils in the opposite direction to that in which the current from the machine itself would pass. In shunt-wound machines, this would not happen, for as a motor the field winding shunts both the armature and the line.

If a dynamo were started with the field or armature connections reversed, whatever residual magnetism there may have been would be destroyed. When a field circuit is broken too suddenly the residual magnetism is sometimes brought down to zero or even reversed. When a dynamo loses its residual magnetism, or charge as it is called, the pole pieces will have little or no attraction for a piece of soft iron.

There are several ways in which the charge may be restored. A series dynamo seldom loses its charge so entirely that it will fail to pick up a field on short-circuit. When a compound-wound dynamo refuses to pick up with its shunt field, it can often be made to pick up by disconnecting the shunt coils and short-circuiting the machine through a small fuse that will prevent damage from the short-circuit. The same idea may be used on a plain shunt-wound dynamo by temporarily connecting all the shunt coils in multiple instead of series. A machine can usually be made to pick up a field by simply short-circuiting the armature by holding a piece of copper wire across the brushes or by rocking the brushes back from their neutral position. This has the effect to make the magnetism of the armature help the field to build up.

If none of these remedies produce the desired results, the fields must be recharged from an outside source. If the dynamo runs in multiple with other dynamos, this is an easy matter. It is only necessary to lift the brushes, or disconnect one of the brush-holder cables on the dead machine and throw in the main line switch the same as if the machine were going into service with the others. The fields will then take a charge from the line and the polarity will be correct. After the fields have been charged, the brushes or cable must not be moved until the main line switch is open, or a short-circuit will be made. If the dynamo does not run in multiple with another and there is a dynamo within wiring distance, disconnect the shunt field of the dead dynamo and connect it to the live circuit. Several cells of an ordinary battery may be used for charging the fields. In this case connect the field coils in series with the cells in series, and give the poles pieces of the dynamo repeated knocks with a hammer, while the charging is going on. If this fails, reverse the terminals of the battery and repeat the operation; it may be that the first time the battery is applied its magnetizing force opposes what little residual magnetism there may be in the iron. When all other available sources fail, connect the fields so as to obtain the least possible resistance, put them in series with the armature through a small fuse, and speed the armature considerably above the usual rate.

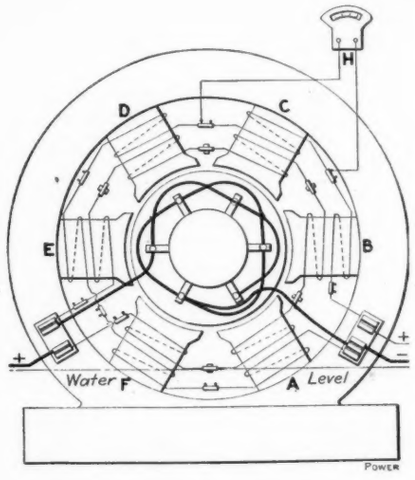
# CORRESPONDENCE

## Replacing Coils in Motor

A 100-hp. compound-wound, 550-volt direct-current motor was located in a well and direct-connected to a centrifugal pump. During unusually wet weather the water came up to the level indicated in the illustration, causing coil *A* to short-circuit and burn out. This brought on a series of troubles which required almost three days' work to overcome.

Coil *A* was taken out and sent to the shop to be rewound. As all the other coils appeared to be in good condition they were not taken out or tested. We had an extra motor which was a duplicate of the one in trouble, from which a coil was taken and put in place of coil *A*. The motor was started and the duplicate coil began to heat. As the motor from which this coil was taken had not been in use for some time, we assumed that there was trouble in the coil. It was taken out and replaced by coil *A*, which by this time had been repaired; but upon starting the motor, coil *A* began to heat again.

It finally occurred to us that it might be well to do some testing to locate this trouble. Accordingly a voltmeter was connected across the terminals of each field, as shown at *H;* then having disconnected the leads of the series winding, the current was put through the




Motor with Coils Indicated

shunt winding and the drop through each coil was measured; the result was:

Coil *A* = 130 volts.
Coil *B* = 100 volts.
Coil *C* = 97 volts.
Coil *D* = 98 volts.
Coil *E* = 100 volts.
Coil *F* = 15 volts.

From this we judged that a drop of about 100 volts was right and that coils *A* and *F* were wrong. Coil *F* was taken out and found to be water-soaked. Another coil was put in its place with coil *A* still in, and the motor started, but coil *A* continued to heat. The drop was measured again and all the coils were found to give close to 100 volts except coil *A*, which still showed 130 volts.

Coil *F*, having been repaired, was inserted in place of coil *A*, after which the motor was started and ran all right.

It was then discovered that a mistake had been made in rewinding coil *A* by giving it too much resistance. Our trouble might have been lessened if we had taken the trouble at first to make the voltage test. Furthermore, when a field coil is changed it is always best to test the polarity of the poles. This polarity test

is made by sending current through each coil and noting the polarity with a small pocket compass. If correct, each alternate pole will be of the same polarity. After work of this kind has been finished, the motor should be given a final test for grounds.

FREDERICK L. RAY.

Louisville, Ky.

## What Reversed the Motor?

A ¼-hp., 110-volt direct-current motor taking current from central-station mains and directly connected to a 24-in. exhaust fan, was originally designed a series machine, but was changed into a shunt machine by placing the series field in shunt and inserting a resistance coil in series with the field windings.

The motor ran this way for a number of years, until it suddenly refused to run at all and upon investigating, the windings of both field and armature were found to be completely burned out. The machine was taken down and completely overhauled and after testing and finding everything in good condition it was connected to the fan again, all connections being made as before. It ran all right except that the fields showed a disposition to heat.

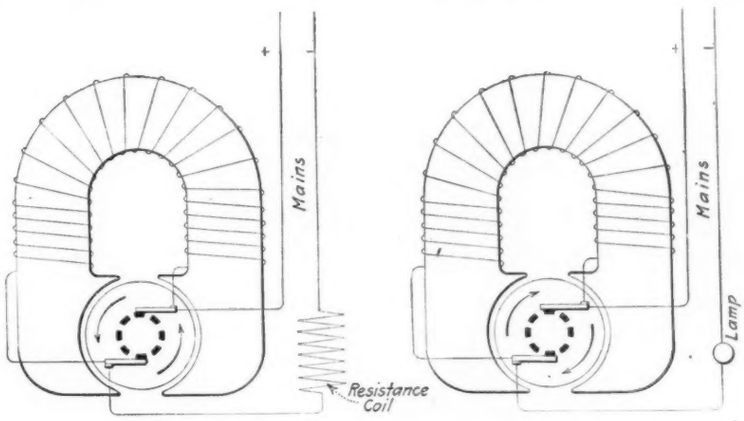
Thinking to lessen the field current, a 50-watt lamp was inserted in place of the coil, as in Fig. 2. Upon applying the current, however, the motor was found to rotate in the opposite direction and at a higher speed than before. No other connections were changed whatever; except those necessary to put the lamp in place of the resistance coil. The coil was replaced, and the machine was reversed again, assuming its original direction of rotation.

Later we took out the coil and connected it up as a regular series motor. It has now been running about a week and shows no signs of trouble; but what changed the direction of rotation?

If any engineers have had a similar experience, or can advance some logical reason for these peculiar actions, I should be glad to hear from them.

F. P. BOONE.

Des Moines, Iowa.




FIGS. 1 AND 2. MOTOR WITH COIL IN CIRCUIT AND WITH LAMP IN CIRCUIT

## Running Three Phase Motors on Single Phase

Some time ago I was employed in remodeling the motive-power department of a large manufacturing plant which had been closed down for several months. It was desired to run several small motors about the plant for doing repairs and construction work, such as running lathes, drills, pipe machines, pumps and hoists for building material, but as the motors were all three-phase machines and the only current obtainable was single-phase of the same frequency it appeared to be a case for single-phase motors.

The three-phase machines would give about one-half of their rated capacity when running on single-phase current, but would not start themselves even under no load. The problem was then to find the easiest way of bringing them up to full speed, after which the load could be applied. A spare motor of the variable-speed type was set up and connected to its controllers in the regular way for three-phase current.

All the other motors to be used were hooked up for three-phase connections and three wires were run to all the motor switches and controllers. The two wires of the single-phase system were then connected to the two outside wires of the three-phase connections and a fuse was placed in the middle wire of the spare motor having twice the capacity of those in the two outside wires.

The spare motor was a low-speed type (600 r.p.m.), and had a large pulley on its shaft. When power was required for the other motors one man would revolve the shaft of the motor as fast as possible by pulling on the rim of the pulley, while another man would gradually cut out resistance in the controller as the motor came up to full speed.

This motor would then be left running idle and would generate three-phase current in its stator winding that would bring the other motors up to speed even when they were running with all the belts in place and partly loaded. This was found to be very convenient and this practice was continued for several months, until the demand for power became great enough to warrant the running of a three-phase alternator.

There were also a number of small motors in this plant that had absorbed considerable moisture. To dry them out, a small alternating-current motor was belted to a direct-current generator of low voltage and the direct-current mains were connected to one phase of the three-phase motors. The direct-current voltage was then adjusted to a point where full-load current was flowing through the windings of the motors. This was maintained until the insulation showed sufficient resistance; then the windings were given a heavy coating of insulating varnish.

A. J. DESAND.

St. Thomas, Ont., Canada.

## Commutator Lubrication

Much has been written by POWER readers about commutator lubrication. However, I have had the care of dynamos and motors for the past seven years, and have never used a lubricant of any kind. I keep the brushes and commutators clean, free from copper and carbon dust, and the brushes well fitted to the commutators, and have found the lubricant that is put in the brushes during manufacture to be sufficient.

J. P. LAUTHERS.

Fort Miller, P. I.

## Oil Switch Refuse to Release

The 3000-kw., 11,000-volt generator was protected by an automatic remote-controlled oil switch having a time-limit relay set for 2 sec. This refused to trip out one day, on a short-circuit, and the efforts of the switchboard operator to trip it from the board proved futile. He, therefore, rushed downstairs to the switch compartment and threw the switch out by hand. By this time the sealing water in the turbine gave out, and admitted air, which broke the vacuum. A spare switch was put into service, the vacuum restored and power was on the line in 5 min.

When the defective switch was taken apart it was found that the copper from the upper contacts had melted, and adhered to the bottom contacts, so that the tripping magnet was not strong enough to pull the contacts apart.

THOMAS SHEEHAN.

North Adams, Mass.

# Gas Power Department

**Worth-while gas-engine and producer information treated in a way that can be of practical use**

## The Junkers Engine—II

By F. E. Junge

### A 1000-hp. Junkers Oil Engine

It is well known that the design of a small engine, however good, cannot always be applied to large units. The enlargement of dimensions, while retaining the constructive arrangements of the smaller type, may not only lead to difficulties in production and intolerable conditions in service, but may change economic conditions. Hence, a thorough investigation of the various relationships was necessary, and on these the preliminary experimental studies of Professor Junkers were concentrated.

But even the deductions from these researches could not alone determine the value and utility of the prospective engine. A single factor, such as reliability of lubrication or ignition, cannot be balanced by other features, however excellent. Hence, the value of an engine can be judged only upon the machine as a whole. Especially is this true with large engines operating on the Diesel principle, due mainly to the very high temperatures and pressures employed.

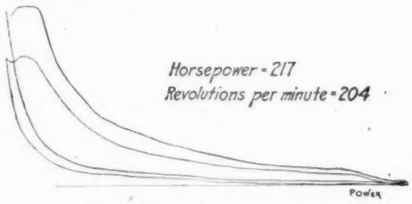



Fig. 7. Indicator Diagram

The first experimental engine built by Professor Junkers was designed for high pressures (100 atmospheres) and permitted an increased output of 50 per cent. above the normal. (200 hp.) The tests on this engine embraced, among other things, the efficiency of scavenging, the consumption of scavenging air, the completeness of combustion with various

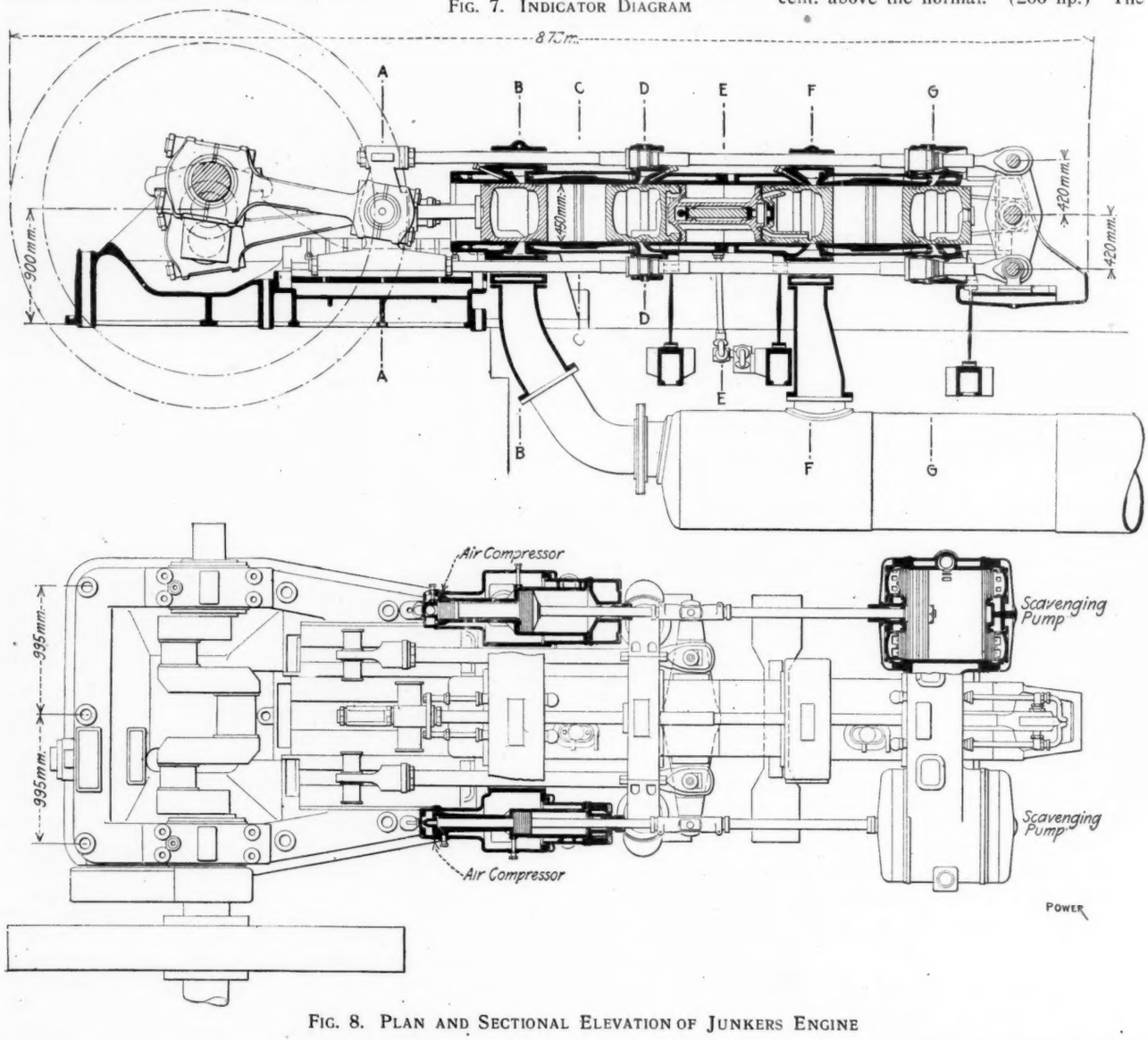



Fig. 8. Plan and Sectional Elevation of Junkers Engine

forms of injecting nozzles and different modes of fuel influx. Different kinds of fuels, such as various residues, mazout, paccura, and coal-tar oils, being used.

inder, and the four-stage air compressor is arranged on both sides of the front cylinder, two stages on each side. The scavenging pumps and the air compressinder has two fuel valves and one starting valve. The driving shaft is underneath the engine and drives two short camshafts carried by rocking frames,

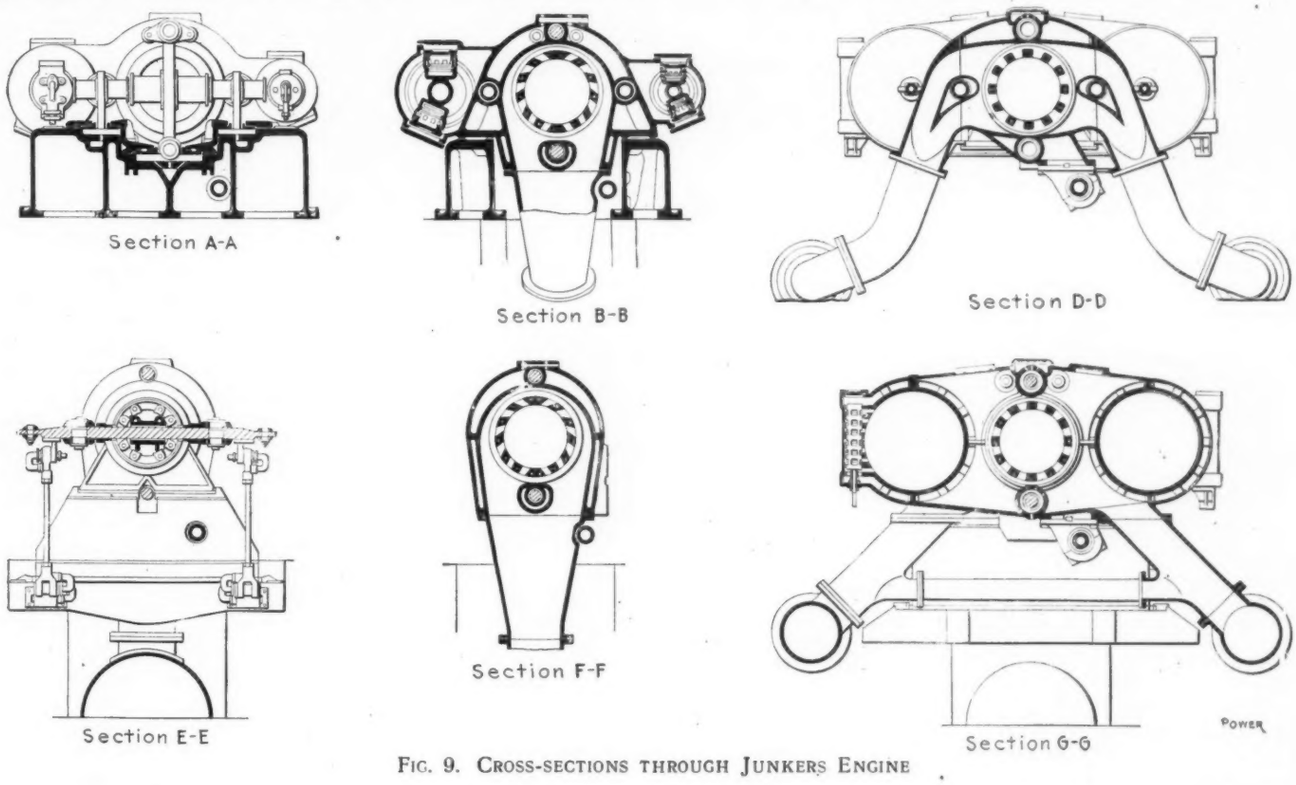



FIG. 9. CROSS-SECTIONS THROUGH JUNKERS ENGINE

Under normal running conditions at approximately 200 r.p.m. a fuel consumption of less than 0.4 lb. (200 grams) per effective horsepower was attained. The high mean effective pressure obtained from the indicator diagram was about 140 lb. per sq.in. under normal conditions, and 200 to 214 lb. per sq.in. with an overload; moreover the invisible exhaust showed efficient scavenging and complete combustion. Fig. 7 shows an average indicator diagram obtained on a 3-hr. test with 500 per cent. overload.

An extension and continuation of the tests undertaken on the 200-hp engine was carried out on an engine of 17.7 in. (450 mm.) bore and a 17.7-in. stroke of each piston yielding 1000 hp. The engine is built in tandem like the smaller one and is capable of 50 per cent. overload. It is also provided with a reversing gear. Moreover, to reduce the total length of engine the distance piece formerly employed was dispensed with, the bridge piece as well as the rear traverse piece being guided in slots at the extremities of the cylinder, a ratio of total stroke to diameter of cylinder of 2:1 was determined upon. Figs. 8, 9 and 10 show the plan, longitudinal, and cross-sections of the 1000-hp engine. The connection of the piston rods and the side rods with the cross-pieces is accomplished by means of moveable joints in order to avoid unequal stresses. The scavenging pumps are at both sides of the rear cylsors are actuated by the center traverse piece. This mode of operation is simple, reliable, and is accomplished with small frictional work.

The scavenging air is lead to the cylinders from both sides with as little obstruction as possible, see sections *DD* and *GG*. The exhaust ports are so arranged as to allow a uniform exit of the escaping gases along the whole of the circumference of the cylinder as shown in sections *BB* and *FF*. The valve gear of the engine is actuated by cams as shown in Figs. 10, 11 and 12. Each cylfor each cylinder, one being used for reversing. By rotating the rocking supports about the center line of the driving shaft from the controlling platform the ahead and reversing cams may be brought into contract with the valve-lever roller. Fig. 11 shows the valves closed in the ahead position and open in the reversing position. On each of the camshafts a starting cam is situated between two injection cams. The lower fuel valve of each cylinder is actuated directly by a lever and the upper valve by a system of links. Fig. 12 shows the action of the starting

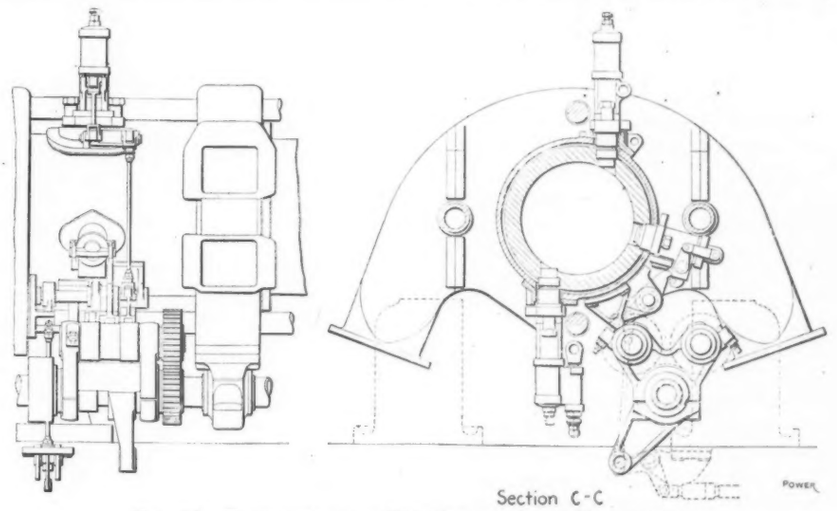



FIG. 10. ELEVATION ANE SECTION THROUGH VALVE GEAR

valve, both when the engine is running ahead and when reversing. The three rollers for each cylinder are placed in axial alinement with each other, the interposed lever for actuating the starting valve being mounted on an eccentric journal, so that it can be put out of action by the levers leading to the controlling platform. For reversing it is only necessary to swing the rocking frame over and keep the starting valves in action till the engine rotates in the reverse direction.

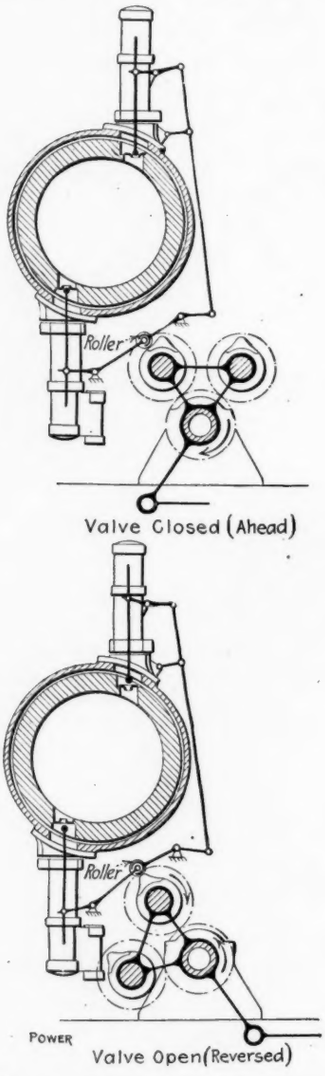



FIG. 11. FUEL VALVE MECHANISM

The advantages claimed for a large oil engine of this design are as follows:

1. The engine realizes the two-stroke-cycle principle with its admitted economic advantages and solves the important and difficult problem of providing good scavenging by the aid of the pistons.

2. The use of two pistons and the illustrated solution of the mechanism connecting them with the crankshaft permits balancing the reciprocating parts, taking up the forces exerted by the pistons in the mechanism itself, instead of the frame absorbing the unbalanced forces. Thus the main engine parts experience only such stresses as are created by useful external forces, and are free from uncontrollable heat and internal-strains.

3. The subdivision of the aggregate stroke by using two pistons permits a high ratio of stroke to diameter of cylinder, simultaneous with a high rotative speed, thus insuring favorable economic conditions, which are increased by the form of combustion chamber.

4. Dispensing with the cylinder cover and the scavenging valves reduces largely those difficulties which are caused by excessive stresses in the material, owing to wide temperature ranges in the cylinder wall.

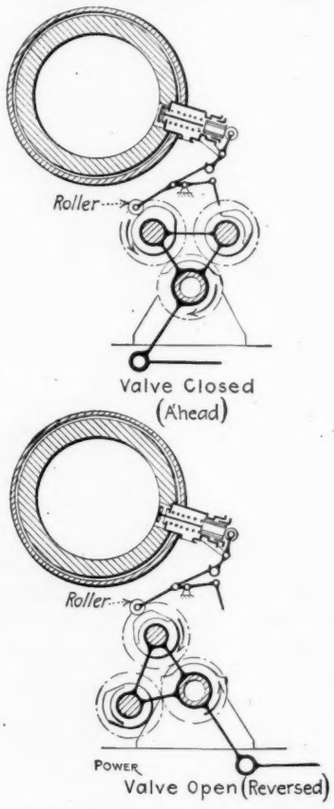



FIG. 12. STARTING VALVE MECHANISM

## Tar Oils in Diesel Engines

A recent test on a 480-hp. Diesel engine in Maiderich, Germany, showed that crude heavy tar oil can be successfully used as a substitute for the lighter oils in Diesel engines. It is known that when hard coal tar is distilled there are obtained, besides benzol and naphthaline, both of which are now used in internal-combustion engines, a number of light, medium and heavy tar oils, the last remaining products of the series being anthracen oil and pitch. Likewise, if brown-coal tar is distilled a series of oils is obtained beginning with benzene and followed by solar oil, light paraffin oil, dark paraffin oil, gas oil and creosote oil.

Formerly only the lighter grades of the oil had been successfully used in Diesel engines, although attempts were made to use raw tar directly. This, however, is a rather crude method because all the valuable byproducts of tar are lost by combustion. Now manufacturers have succeeded in using also the heavier grades of tar oil which are cheaper, costing 45 marks ($10.70) per ton, while the lighter grades cost 50 marks ($12), and gas oil, which is used for starting, 110 marks ($26) per ton, f.o.b.

The Diesel engine on which these trials were made is of the standard four-stroke-cycle type, having 4 cylinders. The compression during ignition is 33 atmospheres and the compression of the air for fuel injection 60 atmospheres (485 and 882 lb. respectively). The shaft which carries the eccentrics for operating the fuel valves, rotates at half the speed of the main shaft. Either compressed air, if available, or carbon dioxide is used for starting. Before the engine is warmed up gas oil must be used as auxiliary fuel, afterward tar oil can be used exclusively, even when the engine has been shut down for 2 or 3 hr. After a continuous run of several weeks it was found that the presence of soot in the cylinder was due not to the fuel itself but to a more than liberal application of lubricating oil. The only trouble experienced was with the fuel pumps, which showed signs of wear due to the tarry constituents.

A remarkable feature ascertained by this test was that, although the heat value of the heavy tar oil is 400 cal. less than that of the light tar oil, not only was the average consumption at all loads lower, but the speed variations were considerably reduced, and the engine ran quieter.

Another interesting observation was that the fuel consumption at full load was about 3 per cent. higher than at ¾ load; this slight increase probably being due to the fact that for the comparatively low heat value of the heavy tar oil full load is synonymous with overload.

When light tar oil was used the fuel consumption at ¾ load was 320 gm. plus 27 gm. gas oil for starting, which, with prices as quoted, corresponds to a fuel cost of 1.9 pfennig or 0.45c. per kw.-hr. When crude heavy tar oil was used the fuel consumption at ¾ load was the same and the cost 1.72 pfennig or 0.40c. per kw.-hr. When no gas oil is added the fuel cost is equal to 1.04 pfennig or 0.25c. per b.hp.-hr. As the most favorable consumption is reached at 80 per cent. load, it is commendable to use light tar oil above this limit, if highest economic efficiency is to be secured. Computing the total operating cost for 300 days in the year, at 20 hr. service per day, and 80 per cent. average load, which include, beside fuel, charges for lubrication, water, attendance, upkeep and repair, the service of one effective horsepower-hour, at prices obtaining in Germany, costs 1.75 and 1.52 pfennig, or 0.42 and 0.36c., for light and heavy tar oil, respectively.

# Heating and Ventilation

**Considered as power-plant problems. Layout and operation of systems and apparatus**

## Heat Transmission through Corrugated Iron

By A. H. Blackburn*

The modern tendency to construct shops and manufacturing establishments with large window areas, the concrete or steel frame often forming little more than a grid for the windows, has directed much attention to the calculation of the heating requirements of such buildings. The Green Fuel Economizer Co., of Matteawan, N. Y., recently had an opportunity to ascertain the transmission through a building of this kind, the structure being a shop for the manufacture of its fans and blowers, and the results will, no doubt, be of general interest.

The shop measures 225x48 ft., with an average height of 32 ft. There are continuous windows on one side 15 ft. high and on the opposite side 19 ft. high. Otherwise, the building is covered with corrugated iron of single thickness without lining. The crevices at the eaves are filled with asbestos and the corrugated iron is cemented in at the bottom, and other measures have been taken to make the building as air tight as possible. The exposure of the windows is east and west, the smaller windows being on the east side.

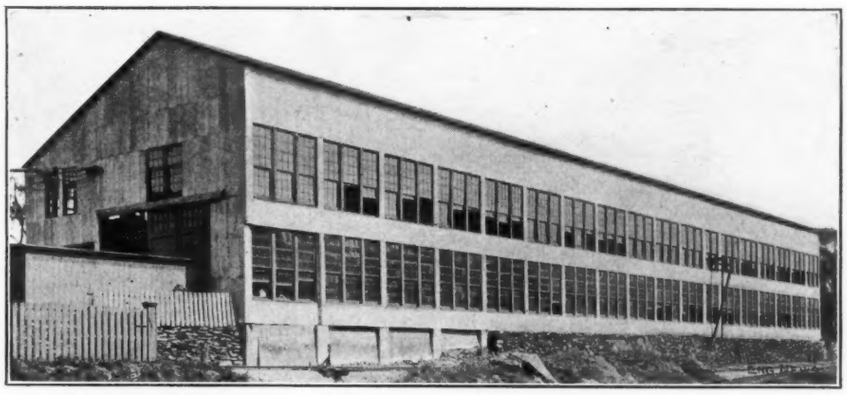


Fig. 1. Exterior of Fan Shop Covered with Corrugated Steel Sheathing

Coefficients given by different authors for the rate of heat transmission through single windows vary somewhat. Prof. Homer Woodbridge gives for single windows with a southern exposure, a coefficient of 1 B.t.u. per sq.ft. per hr. per deg. difference in temperature between inside and outside. For northern exposure he suggests adding 35 per cent., for eastern exposure 15 per cent., and for western exposure 25 per cent. Ludwig Dietz, quoting Dr. Rietschel, of Berlin, and also the specifications of the Prussian Government, give for single windows 1.026, and Dr. Rietschel suggests increasing this 10 per cent. for northern exposure or northeasterly or northwesterly exposures, and 10 per cent. for especially strong winds. The only figure for corrugated iron without sheathing that has been found is one by Rietschel of 2.132, but without any statement as to whether this refers to superficial wall area or to the actual surface of the iron.

Various attempts have been made to analyze the coefficient of heat transmission from one fluid to a solid substance and from the solid to a second fluid. The formula commonly employed is of the form,

$$k = \frac{1}{\frac{1}{A_i} + \frac{1}{A_o} + \frac{x}{e}}$$

where

$A_i$ = Transmission from the inside fluid to the wall surface;

$A_o$ = Coefficient of heat transmission from the outside wall surface to the second fluid;

$e$ = Conductivity of the material in heat units per square foot per hour per degree difference per inch of thickness;

$x$ = Thickness in inches.

For the value of $A_i$ and $A_o$ Grashof gives the following equation:

$$A = c + d + \frac{(40c + 30d)}{10{,}000} T$$

in which $c$ depends upon the velocity of the fluid. Rietschel gives for air at rest $c = 0.82$; for slow motion, as in contact with cold windows, $c = 1.03$; for rapid motion, as outside of buildings, $c = 1.23$. For glass $d$ is given as 0.60 and for sheet iron as 0.57. For single windows $T$ is given as 36, no value being given for iron.

Calculating from the above values, it is found that for a single-glass window $A_i = 1.84$ and $A_o = 2.07$. For sheet iron $A_i = 1.81$ and $A_o = 2.04$. For $e$ Rietschel gives 190 for iron and 6.6 for glass. It is evident that the term $\frac{x}{e}$ in the denominator of the expression for $k$ can be neglected for iron and is practically negligible for glass.

Using the values of $A_i$ and $A_o$ just found, $k$ for a single window works out as 0.958, and for a single thickness of sheet metal as 0.955, or practically the same. This is not taking account of the additional surface of the sheet metal wall due to the corrugations, which in the building under discussion number one to every 2½ in., the depth of the corrugation being 1 in. The actual surface of the metal is approximately 1.35 times the superficial area. This would make the rate of heat transmission for corrugated sheet iron, figured on the basis of superficial area, approximately

$$1.35 \times 0.955 = 1.29.$$

That the values obtained by Grashof's method for both glass and sheet iron are lower than the values used in ordinary practice may possibly be explained on the hypothesis that the constants used in ordinary practice have been increased to account for losses due to leakage, the opening and shutting of doors, etc. Weight is lent to this view by the results of the tests which follow, bearing in mind that the construction of the present building makes it practically air-tight. At the same time the values obtained were slightly greater than Grashof's formula would call for. Any close agreement is not to be expected, as the sheet-metal-working machinery and shafting housed in the building were in constant operation during the test, producing heat which was not measured, while on the other hand, doors were being opened for the passage of men and materials on an average of once every 10 min.

Of the total surface of the building approximately 7538 sq.ft. is windows, in-

*General manager of the Green Fuel Economizer Co., Matteawan, N. Y.

cluding the sash, 8247 sq.ft. is wall surface and 11,925 sq.ft. is roof; the walls and the roof are given in superficial area. The total of wall and roof areas is 20,172, which, increased by the factor 1.35 to account for the corrugations, gives 27,130 sq.ft. total metal surface. The total superficial expanse of the building is 27,710 sq.ft., and the total actual surface, counting the metal in the corrugations, is 34,658 sq.ft.

To heat the building an engine-driven centrifugal fan draws air through a hot-blast heater having six 7x8-ft. sections of four rows of pipe each. There are altogether 6816 lin.ft. of 1-in. pipe in the heater, or 2272 sq.ft. of heating surface. The heater is ordinarily drained of condensate and air by a Dexter vacuum system. Circular sheet-iron conduits with

methods were employed. First, it was calculated from the amount and rise in the temperature of the air passed through the heater, and second, from the condensation in the heater. For the latter purpose, the steam pipe from which the steam was introduced to the heater was carefully drained and the condensate from the heater was weighed. Figured by the air method, the consumption of heat was 2,084,000 B.t.u. per hr., and by the condensate method, 2,029,730 B.t.u. per hr. Using the air figures, the average rate of heat transmission through the superficial area of the building, that is not counting the corrugations, was 1.42 B.t.u. per sq.ft. per hr. per deg. difference, and using the steam value, 1.38 B.t.u.

Taking Professor Woodbridge's figures

such difference between the iron and the glass. Allowing for the many undeterminable conditions, it would probably be safe in calculating the heat supply for buildings of this kind to provide for a coefficient of transmission of 2 B.t.u. for the whole wall and roof area.

The coefficient of transmission through the surface of the hot-blast heater in this test was 9.41 B.t.u. per sq.ft. per hr. per deg. average difference in temperature between the air and the steam, figured by the ordinary arithmetical method, in which the average difference in temperature between the steam and the air is assumed to be the difference between the steam temperature and the mean of the air temperature on entering and leaving. According to the logarithmic formula, which takes account of the fact that the

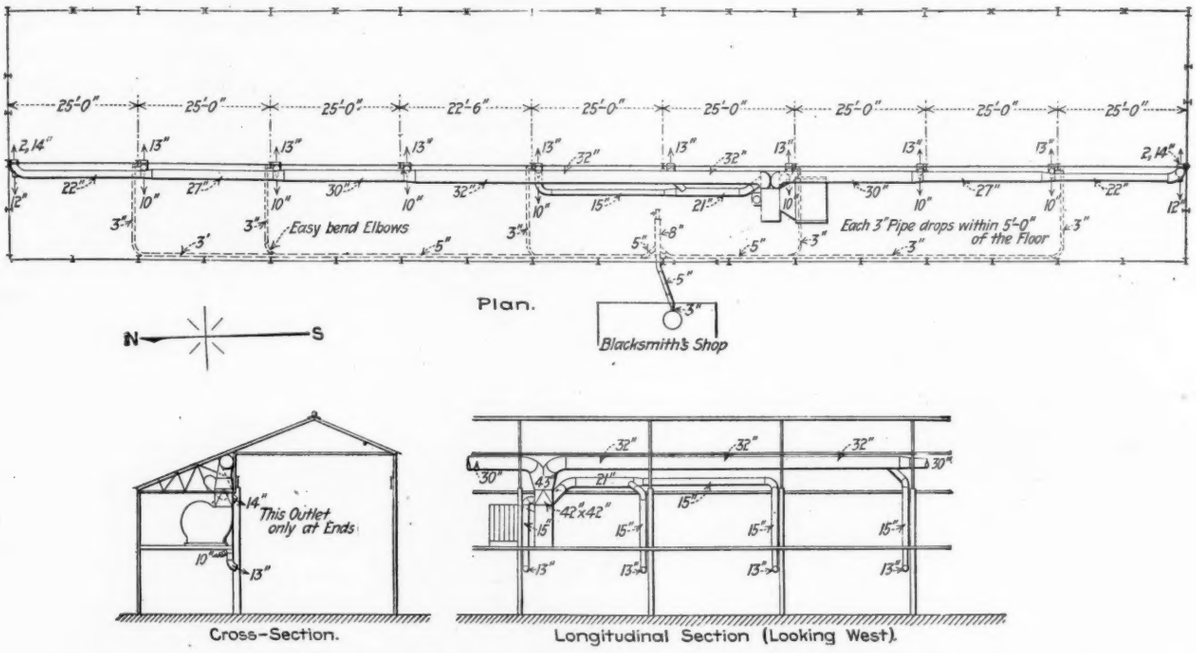



FIG. 2. PLAN AND SECTIONS OF BUILDING ON WHICH TESTS WERE MADE

outlets directed down into the zone occupied by the workmen distribute the air throughout the shop.

The fan and heater had been running for about three hours when the first readings were taken at 8:30 a.m., and the temperature of the shop was maintained constant until readings were discontinued at 11:30 a.m. During the test the fan was run at 258 r.p.m., receiving 22,416 cu.ft. of air per minute, figured to 50 deg. F., the air actually being received by the heater at 73 deg. F. and delivered from the fan at 156 deg. F. The temperature of the steam in the heater was 212 deg. F., and of the air delivered from the farthest outlet 141½ deg. F. Under these conditions, the temperature of the building, measured 3 ft. from the floor, was 66 deg. and measured in the gallery, 70 deg., the temperature out of doors being 15 deg. F.

For determining the total heat, two

for the rate of heat transmission through the windows gives for a window on southern exposure, 1 B.t.u. per sq.ft. per hr. per deg. difference, which, however, is to be increased 15 per cent. for eastern exposure and 25 per cent for western exposure, or in the present case, an average of approximately 20 per cent. Figuring the window surface as 1.2, the value for the corrugated iron, figuring superficial area only, is 1.5, or figuring the whole surface of the iron, 1.13. This is less than an equivalent amount of glass surface and seems hardly likely, although the rate of heat transmission per square foot of actual surface through corrugated iron may be less than through a flat iron surface.

By taking 0.958, obtained by Grashof's method for glass windows, the value for the actual iron surface comes out at 1.19, but on the basis of this formula, there would be no reason for expecting any

air rises more rapidly in temperature in passing over the first rows of tubes than in passing over the later rows of tubes, the value is 10. The mean physical velocity of the air through the heater was 1210 ft. per min.

In a subsequent test, with air entering at 72 deg. F. and leaving at 166 deg. F., and steam at 213 deg. F., in which the velocity of the air was 760 ft. per min., a coefficient of transmission of 7.5 (logarithmic) was obtained; 10 and 7.5 are in the ratio of the 0.64 powers of the respective velocities; that is, the coefficient did not vary directly as the velocity, as frequently asserted. If, instead of mean velocity, flow in pounds of air per minute through the heater is used, which amounts to the same thing as velocities reduced to a standard temperature, the coefficients are found to be in the ratio of the 0.62 powers of the rates of flow.

# Friction Loss in Wrought-Iron Pipe

By W. L. Durand

In the July 9 issue appeared an article by Ira N. Evans entitled "Friction Formulas for Commercial Pipe." In it he has taken six of the best formulas for the friction of water in commercial wrought-iron pipe and the results of several tests and compared them in tabular form and also in a series of curves. The values are given in friction head per 100 ft. of pipe and include velocities up to 15 ft. per sec. and commercial sizes of pipe from 1 to 12 in.

Due to the widely varying tables that appear in different handbooks and the necessity of elaborate interpolation to make them usable, a great deal of time is generally wasted in solving problems in which friction of water in pipes is a factor. From a close examination of the table given by Mr. Evans, evidently using the average value of all the formulas will give results as close as could be desired in hydraulic work.

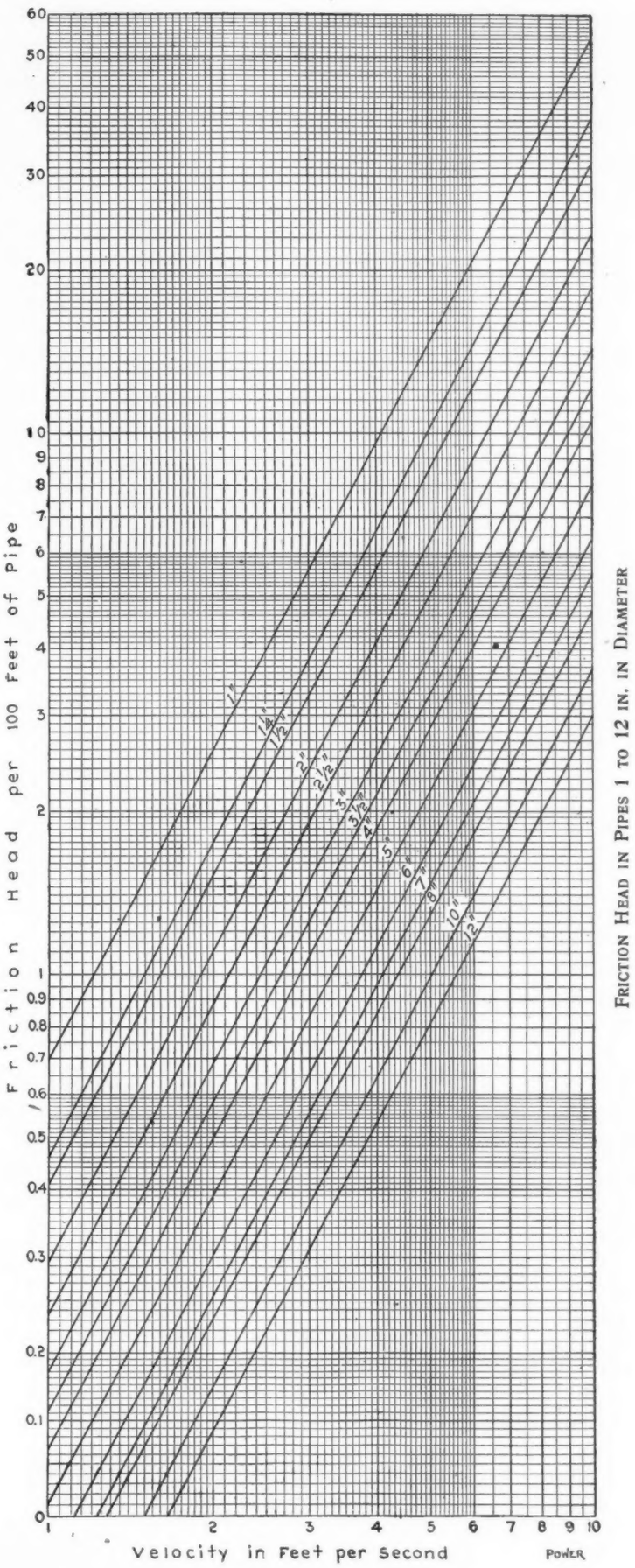
These values seemed to be so much superior to any previously published that I plotted them on logarithmic paper and have used the chart with a great saving of time.

In plotting on logarithmic cross-section paper, in which the rulings are made at distances proportional to the logarithm of the number, all equations of the general form $y = B\,x^n$ will plot as straight lines. Several of the formulas are of this form, and those that are not vary from a straight line to only a slight extent. The average values then may safely be represented by a straight line, as the greatest variation will be much less than the difference between any two values that make up the average.

The method of using these curves is self-evident, there being three variables and in any problem containing two of them the third can be found immediately from the chart. If only one variable is known several values of one of the other two may be assumed and the corresponding values of the third found from the chart. The values that seem to best fit the problem may then be chosen.

The chart is plotted with velocities from 1 to 10 ft. per sec. as abscissas and friction head per 100 ft. from 0.1 ft. to 100 ft. as ordinates. Each curve is for a definite pipe size as indicated, and with a little variation all the way through for velocities of 1 ft. per sec., the chart shows values practically identical with the averages in the table.

For example, take a 3-in. pipe with a velocity of flow of 6 ft. per sec., the friction head per 100 ft. of pipe would be 5.45 ft. To produce a drop in head of 2 ft. in 100 ft. of 5-in. pipe would require a velocity of 4.7 ft. per sec.




Friction Head in Pipes 1 to 12 in. in Diameter

## New York Chapter Opens Season

On Oct. 14, in the Engineering Societies Building, the New York Chapter of the American Society of Heating and Ventilating Engineers held its first meeting of the season.

The topic up for discussion was the relative efficiency of wrought-iron pipe coils and cast-iron surface used in connection with the hot-blast system. There appears to be very little reliable data on this subject and a great difference of opinion among various authorities. On minor details these differences were reflected at the meeting, but all agreed th the difference in efficiency between wrought-iron coils and cast-iron heaters, all prime surface, was very slight. The efficiency of pipe coils depends largely on the number of pipes deep, the velocity of the air through the surface and the extraction of air from the interior of the pipes. The resistance to air flow was thought to be slightly less in the cast-iron heater, and it was suggested that the wrought-iron showed a tendency to scale up and become less efficient. The cost of connecting up favored the coils.

Cast iron with extended surface showed very poor results at velocities around 1000 ft. per min., but with velocities as low as 400 ft. per min., the radiation obtained per square foot of measured surface more nearly approached that from all prime surface.

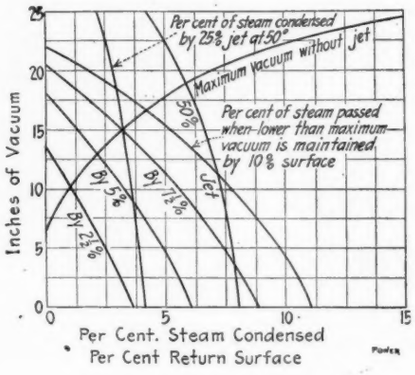
With an air flow through the heater of approximately 1000 ft. per min. it was common to obtain 800 or 900 B.t.u. per square foot per hour from either kind of surface, but a case was cited where the above figures for radiation had been doubled by running up the velocity to 1800 ft. per min.

A report of progress from the committee on moving-picture shows and other routine business was followed by the report of the tellers of election. The officers for the ensuing year are: President, F. G. McCann; vice-president, D. D. Kimball; secretary, Joseph Graham; board of governors, W. M. Mackay, Conway Kiewitz and W. W. Macon.

## Vacuum Heating Chart

In the course of developing a standard method of testing radiator steam traps for return-line vacuum-heating systems, James A. Donnelly, a member of the committee on tests of the American Society of Heating and Ventilating Engineers, devised an interesting chart showing the vacuum which may be maintained with varying percentages of return surface (radiating effect), the percentage of steam passed and condensed in the return when a pressure higher than the maximum vacuum is maintained, and the percentage of steam condensed when jet water is used. The chart is based upon the assumption that the water of condensation is about 10 deg. cooler than the steam from which it is condensed in cast-iron radiators.

A glance at the chart will show that with return surface amounting to 10 per cent. of the radiating surface, it is possible to carry a vacuum of 22 in. With a vacuum of 10 in., 7½ per cent. of the steam would be passed. With 5 per cent. return surface a maximum vacuum of 18 in. can be carried and with 10 in. of vacuum about 3 per cent. of the steam would be passed.




VACUUM HEATING CHART

Using 25 per cent. of jet water at 50 deg. F., the percentage of steam condensed varies from 2 to 4 per cent., with the vacuum carried. With 50 per cent. jet water the percentage of condensation lies between 4 and 8 per cent.

The curve running from the left of the diagram to the upper right-hand corner shows the maximum vacuum which can be carried without jet water, with various percentages of return surface.

# CORRESPONDENCE

## Returning Condensation to Boiler

Recently I was called upon to lay out the heating work for a building which, in addition to a low-pressure heating system, also contained a clothes dryer and a hot-water tank. The clothes dryer is in the basement, which is 8 ft. high and the boiler and hot-water tank in the boiler room, the floor of which is 2 ft. below the basement floor.

The clothes dryer is heated by a coil, containing about 800 ft. of 1-in. pipe, located 12 in. above the floor. As the water line of the boiler is 6 ft. 9 in. above the boiler-room floor, the coil is 3 ft. 9 in. below the water line, so that the water of condensation cannot return directly to the boiler. The coil in the hot-water tank is 12 in. above the boiler water line, but this is not enough to return the condensed steam in the coil. To operate the dryer and hot-water tank requires mechanical means to return the condensed steam to the boiler.

The condensed steam from the dryer and hot-water tank is carried to a receiving tank of about 50 gal. capacity. This tank contains a 9-in. copper float, connected to a tank switch arranged so as to operate on about 6 in. difference of water level. The tank is placed so that the high-water line is 18 in. below the dryer coil. The receiving tank connects to a small electrically driven centrifugal pump controlled by the tank switch so that when the water reaches the high-water line the pump is thrown on and continues running until the water line has dropped 6 in. This pump discharges into the return line from the low-pressure heating system near the boiler, and a check valve is placed on the house side to prevent the pump discharging into the heating system.

The same result could be obtained by using a steam pump in place of the electric pump. To operate the pump, however, would require carrying 15 to 20 lb. pressure on the boiler and using a reducing valve on the line running to the heating system. The exhaust steam from the pump could be used in the heating system by first passing it through an oil separator and installing a back-pressure valve and exhaust line to the roof. This arrangement would cost practically the same to install and would probably be less expensive to operate.

Another arrangement which would be more expensive to install, but would not cost much to operate, would be to carry about 10 lb. on the boiler and use a reducing valve as above. The water of condensation could be brought to a lifting trap placed on the boiler-room floor which would lift into a return trap placed above the boiler. For successful operation, however, the return trap must be at least 3 ft. above the boiler water line. This arrangement could not be used in low boiler rooms unless some place on the floor above could be found for the trap.

With the latter two methods, due to the pressure in the boiler being higher than the heating system, all the water of condensation would have to be returned by mechanical means, instead of only that from the hot-water tank and clothes dryer.

W. L. DURAND.

Brooklyn, N. Y.

Occasionally, pulpit and press give gratifying recognition to the men who keep the industrial wheels moving without making any noise about it. Over 3000 men of nearly every trade and vocation heard a clergyman in St. Patrick's Cathedral, New York, a recent Sunday evening lecture on the rights and duties of labor.

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## Contents

| | Page |
|---|---|
| Plant of Landers, Frary & Clark Co. | 630 |
| A Simple Problem in Horsepower... | 632 |
| Steam Power Plant Pipe Fittings... | 633 |
| Spontaneous Heating of Stored Coal | 635 |
| Thermometers for the Steam Plant | 638 |
| Curbs around Floor Openings..... | 640 |
| Old and Modern Arc Switchboards.. | 641 |
| Why Dynamos Fail to Generate.... | 642 |
| Replacing Coils in Motor..... | 642 |
| What Reversed the Motor?..... | 642 |
| Running Three-phase Motors on Single Phase ..... | 643 |
| Commutator Lubrication ..... | 643 |
| Oil Switch Refuses to Release..... | 643 |
| The Junkers Engine—II..... | 644 |
| Tar Oils in Diesel Engines..... | 646 |
| Heat Transmission through Corrugated Iron ..... | 647 |
| Friction Loss in Wrought-iron Pipe | 649 |
| New York Chapter Opens Season.... | 650 |
| Vacuum Heating Chart..... | 650 |
| Returning Condensation to Boiler.. | 650 |
| Editorials .....651-652 | |
| Readers with Something to Say..653-654 | |
| Repairs to Lubricator Condenser ....Oil Deposit Causes Explosion in Air Line....Peculiar Reversing Mechanism for Launch Engine.... Experience with Automatic Throttle Valve....Engine Room Signal and Telephone System. | |
| Questions Before the House.....655-657 | |
| Scale in Turbine Sealing Glands ....Steam Chart from Hand-fired Boiler....Air Compressor Crank Repair....Excess Air Indicated by Superheat....Tilt Trap as a Boiler Feeder....Systematic Note Keeping. | |
| Inquiries of General Interest..... | 658 |
| Study Questions ..... | 659 |
| New Publications ..... | 659 |

# POWER

## Load Dispatching

In some form or other the load-dispatching function exists in practically every successful electrical distribution system, and as the values of the connected load and the investment increase, the need of centralized control of operation becomes more imperative. Only within the past few years has the work of the load dispatcher been organized on large systems upon a thoroughly scientific basis, and still many central-station and power-service men little realize its scope and value. On the great Western hydro-electric transmission systems and to some extent in the lighting, power and railway properties of the East one finds this specialized work most highly developed. It reaches its greatest value on systems supplied with electrical energy from interconnected plants and whether these installations are steam or hydraulic, a first-class load-dispatching organization becomes one of the most important factors in economical operation.

The dispatching office must give twenty-four-hour service and be fully equipped with telephones, recording and indicating instruments, schematic diagrams or working dummies of all high-tension lines and switches, together with log sheets. The practice of receiving readings of load by telephone or telegraph at short intervals from all important electrical centers on the system, facilitates the handling of generating units, tie lines and transmission lines. While entailing considerable work, it is essential in the economical use of water and fuel, the disposition of station and substation labor and the transfer of loads to permit inspection and repairs.

In the actual work of dispatching loads the frequency meter is important. A drop of even two or three cycles is a hint that excessive loads, governor difficulties or other troubles are being encountered. Prompt work with the telephone, the throwing in of tie lines and possibly the starting up of auxiliary steam plants may be required, and the dispatching force must have good judgment to eliminate needless expense. If the load can be carried in any other way than by bringing cold boilers up to full steam pressure, economy will be served. Where auxiliary steam-plant capacity is likely to be needed it must be anticipated considerably in advance of the load unless oil fuel is employed.

The safeguarding of lines cut out for repairs, the transmission of time signals and general oversight of operation afforded by a good dispatching organization are worth far more than their cost, and we look to see this phase of system administration greatly extended in the future handling of associated generating plants and distributing networks.

## Flyball Automatic Cutoff Governors

Generally there is no good excuse for a governor belt becoming oil soaked, even though it runs direct on the crankshaft. A little time spent in making wipers or a baffle in the form of a disk to be fastened to the crankshaft between the belt and the bearing from which the oil comes would prevent this evil and save the engineer much trouble.

A governor belt should be as free from faults as possible. Not only does the good regulation of the engine depend upon it, but only too often the safety of the engine, its operator and others in the immediate vicinity as well as the buildings depend upon the belt performing its functions properly. An oil-soaked belt that is never cleaned will soon become nearly as great a menace as a weak and overloaded boiler. Of course this is not so if the safety device of the governor is in working order, but in plants where the governor belt through neglect, is rotten, the safety device is usually inoperative through the same cause.

When it is considered that through the exigences of the service, an engineer will speed up an engine beyond the safe rim velocity of the flywheel and at the same time neglect the belt and safety device, the seriousness of the situation

becomes alarming. If the load on the engine is steady and the belt not too oily, trouble is experienced only on starting the engine. In such cases the speed of the governor lags behind that of the engine, due to slipping of the belt, and it is very probable that the safe rim velocity of the flywheel will have been exceeded before the governor speeds up sufficiently to produce an earlier cutoff and reduce the speed of the engine.

Conditions of this kind exist because of the ease with which they are overcome at the moment trouble is likely to occur. By pushing back on the governor reach-rod the engineer secures an earlier cut-off until the governor has come up to speed, when it will take care of itself. A condition so easily surmounted is soon forgotten, until eventually the time comes when the reach-rod is not attended to soon enough and the engine is wrecked and perhaps human life sacrificed to criminal negligence.

Another highly dangerous practice among some engineers is to leave the pins in the governor column after the engine is started. Some do it because they "forget," others, deliberately because "it saves time."

In plants subjected to heavy overloads which come on suddenly, the speed of the engine, and consequently the speed of the governor, is almost instantly reduced unless a very heavy flywheel is used. The governor, therefore, will drop its spindle so far that the safety cam of the releasing mechanism will be forced over against the hook, preventing the catch from engaging the block. This action closes the steam valves just when a large amount of steam is needed to carry the momentary overload. To avoid the closing of the valves at such times some engineers leave the pin in the governor column or block the over-balanced "dog" that serves the same purpose as the pin.

Blocking the spindle will insure steam when the governor speed is suddenly reduced, but it also prevents the governor automatically checking excessive engine speeds if the governor belt should break. The risks taken therefore where such measures are resorted to to avoid interruptions of service are very great, but it is dangerous practice and should obtain only in extreme cases. Human life and property are worth more than the loss entailed by service interruptions.

## Safety First

Greater safety in power-plant operation being a reform we are continually advocating, we would like to add our indorsement to that of other publications, notably the *Railway Age Gazette*, of the "Safety First" movement. Important as are speed and comfort to the traveling public, safety is of much greater moment, and this is the basic principle upon which improvement is urged.

We are not prepared to offer any suggestions as to how safety may be increased in the railway field, but there are several ways in which it ought to be done in stationary power-plant practice, and we intend to keep our lungs and tongues tuned up on this score as long as we feel we can do any good.

Our idea is to hook up a little more than the railroads only to this "Safety First" movement, and we trust our readers will ally themselves with it at once and each do his part to try to have wrong conditions righted in his locality. From time to time, we shall call attention to these wrong conditions, and whenever our friends find them obtaining in their plants they should make it their business to call the attention of the management to them. Such an action is a duty each owes to himself for his own welfare as well as that of the general public.

## Overloaded Boilers

Few things look more harmless than a boiler under pressure; yet few things are so capable of destruction.

With no reflection upon the design or workmanship of any boiler, it is as dangerous a contrivance as humans have to deal with. A designer or maker has meager influence regarding the treatment boilers shall receive after they have been turned over to the purchaser. The engineer also often has little to say about this. His business is to operate them under the most favorable conditions that he can produce—conditions which often conduce to danger rather than safety.

Inadequate boiler capacity is unquestionably common to over fifty per cent. of all plants, chiefly because the owner insists that the engineer "get along for the present." Under such conditions and with service that must not be interrupted, proper care of the boilers is well-nigh impossible. If the men succeed in carrying the peak load, regardless of how hard they force the boilers to do it so long as they are able to hold the water, they feel they are doing well, and they are.

The designers and the makers of boilers can incorporate in their product the best form of vessel, details of structure and metals that all the years of boiler practice have proved superior. To the maker is available the finest facilities and workmen to produce a boiler consistent with the best design. But these boilers, the best, cannot long perform their function if overloaded, forced to the limit and left to care for themselves until so hurriedly examined that serious defects are still undiscovered, when they are again put in service.

With water-tube boilers the usual effect of such operation is the splitting or "letting go" of a tube. If the fireman is unfortunate enough to be charging or cleaning a fire when a tube "lets go," the circumstances of which he is a victim are most vividly portrayed in last week's foreword picture. It does not end with the fireman, however, the whole plant suffers the shock; worst of all, life is often sacrificed to the demands of the service.

The remarkable part of it all is that the men so stoically, so fatalistically accept the horror of such accidents.

## "I" vs. "We"

A man in charge of a plant, or any man having men under him, will secure better results if he does not try to be self-important, but uses a little tact. Men under the direction of another are quick to appreciate consideration at his hands even in small ways. For example, it is just as easy to say, "We must get this work done today," as to say "I want that work done today," and the chances are much more favorable that the work will be done. The use of "we" encourages co-operation, keeps the men interested by suggesting that they have a share in the responsibility and is gratifying to them because it does not remind them of their inferior position.

It's a pleasure to work under a boss who makes you feel that you are working *with* him rather than *under* him. He is the kind that encourages the men to make suggestions in regard to the work, realizing that every man under him knows something that he does not know.

When the boss shows interest in his men he will find they will show interest in him.

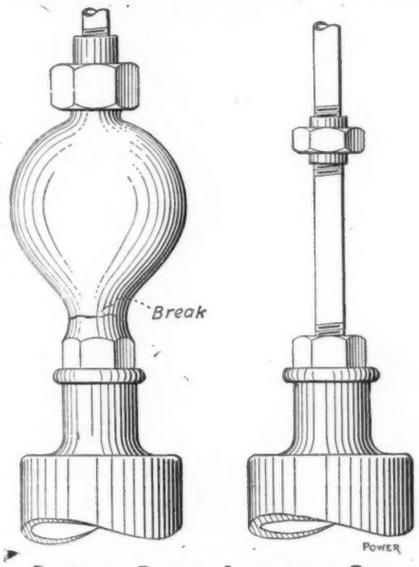
# Readers with Something to Say

**A letter good enough to print will be paid for. Ideas, not mere words, wanted**

## Repairs to Lubricator Condenser

The following account of a repair job that I did while in charge of a small steam plant may be of interest to other engineers.

A governor spring on one of the engines broke, the weight hitting the dome or condenser of the lubricator, breaking




REPAIR TO BROKEN LUBRICATOR CONDENSER

it nearly off at the neck. It was too badly damaged to be soldered and we had no spare one, so I cut the dome off at the break, tapped it out with a ¼-in. pipe tap, reamed the lower end of the pipe out, so it would not interfere with the pipe that runs down into the body of the lubricator and put the pipe into the neck of the dome. I also put a union in the pipe, to permit removing the lubricator, as it was cold weather. When I put it on I filled the pipe with cold water, and the lubricator gave us no trouble. The illustration shows the break and the way it was repaired.

ALFORD H. SMITH.

Rogers, Ark.

## Oil Deposit Causes Explosion in Air Line

We have two 22 and 14 by 14-in. air compressors, discharging into a 6-in. main under a pressure of 100 lb. The receiver is small and located about 200 ft. from the compressors. We get considerable moisture and oil from the receiver, and moisture is carried all through the lines to wherever air is used.

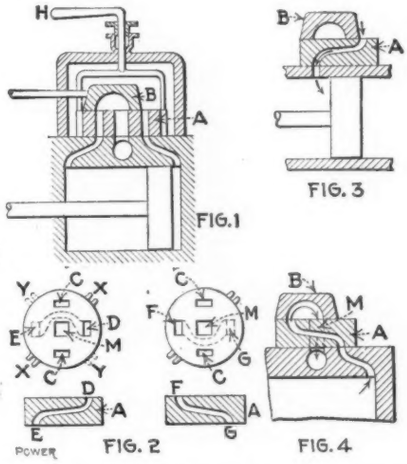
Recently an explosion occurred in the main line, breaking a 6-in. elbow near the receiver. We found the oil had formed a carbon deposit in the pipe which in some way created a gas that later exploded. Can anyone tell me what caused this, and what to do to prevent its reoccurrence?

H. H. DELBERT.

Titusville, Penn.

## Peculiar Reversing Mechanism for Launch Engine

The reversing mechanism described below was found on an old government launch engine. The engine had only one eccentric and that was keyed and setscrewed to the shaft. The steam chest was round and very deep. Inside it was the casting *A* which had two sets of ports, the arrangement of which is shown in Fig. 2. To avoid confusion of too many lines, two drawings in Fig. 2 were made to show how the ports ran. The ports *C* went straight through as did also the




UNUSUAL ENGINE REVERSING MECHANISM

exhaust port in the center. The port *D*, Fig. 2, led through at the other side of the casting at *E*, and the port *F* led out at *G* in the same manner.

At *X* were two lugs which engaged the forked end of the handle *H*. This forked end was inside the steam chest and the stem had a stuffing-box and was packed where it passed through the steam-chest cover. With the lugs *X* in the position shown in Fig. 2 the ports *C* were parallel with the valve in its movement. With the valve *B* on the bottom, as in Fig. 1, steam would be admitted at the head end of the cylinder.

If the yoke lever *H* be thrown 90 deg. in the direction of the arrow, so that the lugs *X* occupy the positions shown by *Y*, the port *D* will be at the bottom and the port *F* at the top. With the valve in the same position, as shown in Fig. 1, steam will be admitted to the top of *A* and enter the open port, and the exhaust from the cylinder will follow a similar course and out through the square exhaust passage *M*. Fig. 3 shows the course of the steam and Fig. 4 the course of the exhaust.

L. A. SUVERKROP.

New York.

## Engine Room Signal and Telephone System

Our plant furnishes power to old mills scattered over a wide area. All the mills contain old shafting, couplings, gear drives and aged belts which give much trouble and cause many shutdowns in the course of a year.

The management could not be induced to install an automatic engine-stop system, so I put in a signal-bell system as illustrated. We have a code of signals, known to the repair-shop help, overseers and foremen in the mills and to the engine-room force. This system worked fairly well, though sometimes wrong signals were given and the engine moved contrary to intentions, but it saved time and was better than useless running back and forth between the engine room and the seat of trouble.

We gradually extended the system to all the mills, using a damp-proof office wire for the circuits. Some time ago we had trouble with a jackshaft at the head of a rope drive which kept breaking repeatedly and soon found that the signal code was not sufficient to cover the amount of engine movements required when making repairs. Finally I was permitted to install hand telephone sets on the signal circuits. I permanently attached one 'phone in the engine room to the signal circuit with a long cord so that I could use it and work the engine at the same time. One 'phone was placed permanently at the signal-button station next to the main drive-clutch couplings, another was given the repair gang. Each push-button station had two brass terminal screws connected to the signal circuit so that a 'phone could be attached. A telephone call was added to the sig-

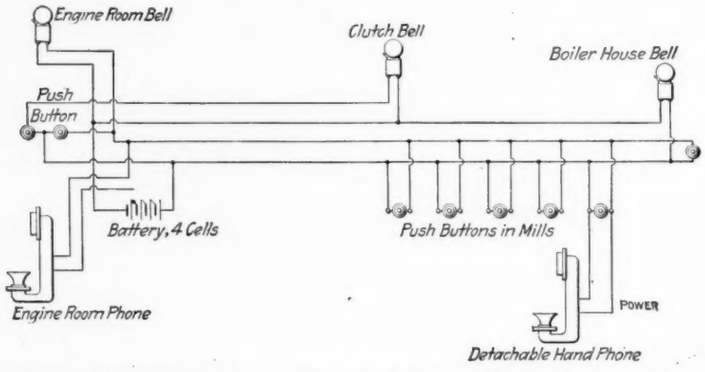
nal code. The latter was not abandoned, but the 'phones were used when the code was found insufficient to convey the messages.

The 'phones have cut in two the time formerly wasted in making shutdown repairs. The shafting oiler also has a hand 'phone which he carries with him when at work on shafting. We also use them frequently when one of the engine-room force is at work on lighting circuits in parts of the mill remote from our interphone system.

A call bell operated from the engine room was placed in the main drive-clutch station and a signal bell in the boiler house is used to notify the firemen to stop or start the waterwheel which is near the boiler house and quite a distance from the engine room.

BENJAMIN S. HANSON.

Broad Brook, Conn.




WIRING DIAGRAM OF ENGINE-ROOM SIGNAL AND TELEPHONE SYSTEM

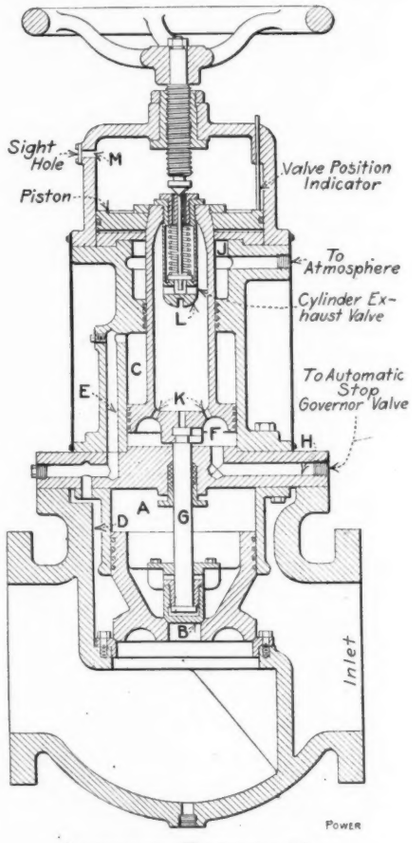
## Experience with Automatic Throttle Valve

The illustration shows the automatic throttle valve of a 3000-kw. turbine. Steam is admitted at the upper side of the lower valve disk filling the space above the valve. By reason of leakage past the balance piston, immediately above the valve disk, full boiler pressure is established at *A*, in the balance cylinder and, so long as the pressure is on its seat. The pilot valve *B* being opened, the pressure in *A* is relieved, and the valve disk becomes balanced. The high-pressure steam entering the valve freely passes into the space *C* above the operating piston through the ports *D* and *E*. It also passes in limited quantities to the space *F* below the piston both by leakage past the piston and around the stem *G*, so, should there be no outlet for the steam at *H*, full pressure will be established at *F*, causing the valve to open as the handwheel is raised, as the upper part of the operating piston, where it enters the dashpot, is exposed to atmospheric pressure only.

Should the pressure be relieved from *F*, steam will be exhausted from below the piston and the pressure in chamber *C*, will force the valve to the closed position. On the upper part of the valve are the dashpot and piston, for preventing the valve from slamming violently maintained, it tends to hold the valve disk on its seat. There is also a valve-position indicator to show the position of the valve with reference to its seat. At *J* is a metallic packing with a connection to the atmosphere to carry away any leakage. There is also a device to prevent the sudden opening of the valve after it has automatically closed. Should the operator reset the automatic stop valve without first closing down the throttle-valve handwheel, it is possible to readmit steam to the turbine slowly instead of instantaneously turning on the full head of steam. This is accomplished by holes *K* through the operating piston, and a spring-loaded valve called the cylinder-exhaust valve, located in the upper part of the operating piston. The lower side of this valve is exposed to the full pressure, which, however, is insufficient to compress the spring. The valve being opened, the valve proper comes up against the body head. The upper stem, however, has a little farther to travel before the head on the lower end of it is stopped against the bushing on the upper part of the dashpot. This permits the cylinder-exhaust valve spring to expand a trifle, but still not sufficient for the steam pressure to force open the cylinder-exhaust valve *L*.

Should the valve close automatically, the operating piston with the valve *L* will descend from the upper throttle-valve stem, when the spring will be entirely released, and the valve *L* will be free to open. Then, if the automatic stop governor valve is closed at this time, thus preventing egress of steam at *H*, it will be impossible for the steam pressure to increase at *F*, because the steam will be free to escape through the holes *K*, the valve *L* and the sight-hole *M*. Hence the valve will not open until the handwheel has been screwed down, forcing the cylinder-exhaust valve *L* to its seat.

One of our turbines is able to handle the load, so we keep it on the line for two weeks, and then change over to the other, which is the same size. Recently, when the engineer on the afternoon watch, changed over the turbines, he found that the operating piston stuck when within about an inch of full open, and that the handwheel had to be screwed down a little to keep the cylinder-exhaust valve to its seat. Everything went well until the night engineer came on duty. He was an experienced and very careful man, but the throttle valve was a mystery to him. Being observant, he was not long on duty, when he noticed the handwheel on the throttle valve was not in the wide-open position, and proceeded to open it. This relieved the cylinder-exhaust valve, and exhausted the steam from *F*, forcing the valve to the closed position, shutting off steam. As a big load was being carried at the time, it did not take long before the turbine came to a stop.




AUTOMATIC THROTTLE VAVLE

It all happened so quickly that the engineer did not know what occurred or how to correct the trouble, so started the other turbine. The power was off the line for 15 min. The chief had the valve taken apart the following day and the operating piston put in the lathe and lightly turned down, which made it a good working fit. Now the watch engineers know more about automatic throttle valves than they ever expected to.

THOMAS SHEEHAN.

North Adams, Mass.

# Questions Before the House

**Comment, criticism, suggestions and debate upon various articles, letters and editorials which have appeared in previous issues**

## Scale in Turbine Sealing Glands

The letter in the Sept. 10 issue, relating to the means devised by Mr. Pivens to obviate trouble experienced from scale forming in the sealing glands on the spindle of his steam turbine was interesting. He is not the first who has had trouble from that source. His apparatus will accomplish the object for which it was built, if the check valve *K* is reversed from the position shown in the illustration in the above issue. With the valve placed as shown, when valve *D* opens to the atmosphere, the air would enter the condenser faster than the tanks and break the vacuum on the system.

The device as shown has another serious disadvantage, in that every time a tank of water is extracted from the condenser practically 20 cu.ft. of air will be admitted to the condenser in which there is 28 in. vacuum. This adds work to the air pump, and unless they are large, will impair the vacuum. I note that pipe *G* leading from the upper tank to the condenser is restricted in diameter $\frac{3}{16}$ in. to prevent impairment to the vacuum. This will also lower the capacity of the apparatus.

I have used a device for this purpose, and accomplished satisfactory results with apparatus that can be bought in the open market and will not admit air to the condenser. All that is required is an automatic vacuum trap that uses a jet of steam to blow the water out into a tank placed at an elevation to give the required pressure on the glands of the turbine. The trap should be set about 6 ft. below the connection in the exhaust end of the turbine and, where a barometric condenser is used, the suction side of the trap should be connected to the lowest point in the exhaust pipe.

Mr. Pivens states that he finds 4 lb. sufficient pressure at the inlet of the glands. My experience is that this pressure is not sufficient for most installations, and the builders' recommendation of 15 lb. will be found to give more reliable action. All turbines do not act alike; while 4 lb. might do in one case, other turbines will require more and engineers who are going to try this scheme had better place the storage tank high enough to give 12 to 15 lb. pressure. There is ample condensation in the exhaust end of the turbine to furnish sufficient water to seal the glands.

I placed some bullseyes in a jet condenser attached to a 2000-kw. steam turbine, and put electric lights inside of the condenser; it was interesting to watch the action of the water as it entered the condenser and the way it was affected when the steam struck it. One of the features that could be clearly seen was the water or condensed steam running down the inside of the exhaust connection from the turbine.

R. D. TOMLINSON.

New York City.

## Steam Chart from Hand-Fired Boiler

There appeared in a recent issue a steam chart showing the pressure maintained in a boiler for 24 hours' run. The letter only told the capacity of the boilers, and nothing about the load they carried. The accompanying chart is shown for comparison. We have two 54-in. by 16-ft. horizontal return-tubular boilers of about 75 hp. each. The draft is 0.19 and 0.21 in. respectively; no damper regulator is used. We burn about 7000 lb. of mine-run coal in 10 hr., and evaporate 92 cu.ft. of water per hour from 212 deg. This is equivalent to 8.2 lb. of water evaporated per pound of coal. We have a 400-amp., 220-volt direct-connected generator. Considerable steam is also furnished for rubber vulcanizers and other purposes.

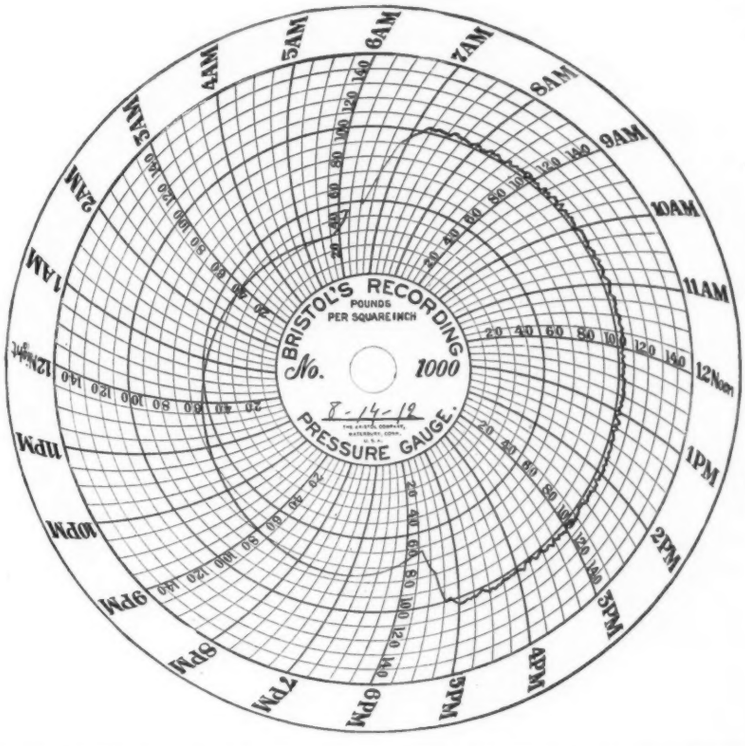
H. M. WALKER.

Chicago. Ill.

## Air Compressor Crank Repair

On pages 432 and 433 of the Sept. 17 issue. T. H. Heath describes the method used to repair a disk crank which had a piece broken out of the eye. The crank disk was stated to have been 26 in. in diameter and of 3½-in. face. The repair consisted of a ring 1¾ in. thick, 3½ in. wide and bored out $\frac{1}{16}$ in. less than the diameter of the disk, heated and shrunk on the disk.

Under the above conditions, the inside diameter of the ring would be $25\frac{15}{16}$ in. bore. The mean diameter would be $27\frac{1}{16}$ in. Neglecting compression in the disk and ring, the extension of the metal in




PRESSURE CHART FROM HAND-FIRED BOILER NOT EQUIPPED WITH DAMPER REGULATOR

the ring would be 0.1965 in. along the mean circumference, of which the length is 86.98 in., or a ratio between this extension and the mean circumference of 1 to 443. Assuming 29,000,000 as the modulus of elasticity,

$$\frac{29{,}000{,}000}{443} = 65{,}463 \textit{ lb. per sq.in.}$$

is the stress, which evidently is too high.

The above assumes that there is no compression in either the disk or ring. While there would be some compression which would tend to relieve this stress somewhat, it would not be sufficient to reduce it to a safe working value. Had the allowance for shrinkage been a scant $\frac{1}{32}$ in. (0.025 in.) the repair would have been more reliable.

J. K. McINTYRE.

Newburgh, N. Y.

## Excess Air Indicated by Superheat

The above subject was discussed editorially in the Aug. 20 number of POWER. With the same fuel as was used in the case mentioned and all other conditions the same, the temperature of combustion depends on the amount of air in the mixture. In ordinary practice the gas per pound of fuel runs from 16 to 35 lb., these figures were found in actual practice, one being a large chain-grate installation and the other a hand-fired 500-hp. plant.

For convenience of figuring and to be within more common practice, take a case where the same coal is burned with 20 lb. of dry stack gas per pound of coal and in the second case 30 lb. of dry gas per pound of coal; the amount of gas per pound of coal can be determined from the coal and gas analyses. If the fuel contains 75 per cent. carbon, 4 per cent. hydrogen and 8 per cent. oxygen and the gas analysis shows 9 per cent. $CO_2$, no CO, for every 12 parts of carbon burned, it requires 32 parts of oxygen to attain complete combustion. The atomic weights of carbon and oxygen are 12 and 32, respectively. Then to burn 12 tons of carbon into $CO_2$ (carbon dioxide) will require 32 tons of oxygen. To burn 0.75 lb. of carbon, therefore, will take

$$(0.75 \div 12)\ 32 = 2 \textit{ lb. of oxygen}$$

To get this amount of oxygen from the air will require

$$2 \div 0.23 = 9 \textit{ lb., nearly}$$

As 0.23 is the amount of oxygen in a unit volume of air by weight, the other 0.77 is nitrogen. The volume of $CO_2$ is the same as the volume of oxygen used to burn the carbon and from analysis is 9 per cent. of the volume of the stack gases. The volume of nitrogen is to the volume of oxygen as 0.23: 0.77; therefore, the per cent. of nitrogen taken in with oxygen will be the same as their volume to each other, that is,

$$X : 9 :: 0.77 : 0.23$$

$$X = 9 \times 0.77 \div 0.23 = 30 \textit{ plus}$$

The total per cent. of $CO_2$ and nitrogen will be

$$9 + 30 = 39 \textit{ per cent.}$$

of the total dry stack gases per pound of coal. If 39 per cent. of the flue gases constitutes 9 lb. of air the total weight of gas per pound of coal will be

$$(9 \div 39)\ 100 = 23.07$$

As 0.75 lb. of carbon and the oxygen and hydrogen present in the coal and passed with the stack gases have not been taken into account, the weight of the total gas will be

$$23.07 + 0.75 + 0.08 + 0.04 = 23.94$$

With no loss of combustible the temperature of the fire will be the total heat per pound of fuel divided by the product of the pounds of gas and the specific heat. The specific heat of gases runs near 0.24 in very many cases in practice and can be taken as such. If the combustible consumed developed 12,500 B.t.u., the temperature must be about 2230 deg. F., moisture neglected. With 20 lb. of gas per pound of fuel the temperature would be 2600 deg. F. and with 30 lb. 1740 deg. F. It is then apparent that the temperature of the gases is directly proportional to the amount of air.

The heat absorption of the boiler depends on the temperature difference, velocity of the gases and the cross-section of the gases. With an increase of the gases the velocity must be greater to take care of the increased volume; therefore, better absorption. With a decrease of the gases, the velocity is less, but the higher temperature difference compensates for the lack of velocity and the gases will leave the absorbing surface of the boiler at about the same temperature.

This fact emphasizes strongly that the rating of boilers at 10 sq.ft. of heating surface to a horsepower is liberal and that seldom are all of the surfaces worked to full capacity. When a boiler is not overworked and the same rate of combustion is maintained, the final temperature of the gases is not affected by variation of the amount of air, unless this variation is stretched beyond the usual practice.

If the gases enter the superheater at 600 deg. F. and leave at 450 deg. F., there is a drop of 150 deg. in the superheater and with 20 lb. of gas per pound of combustible the superheater will absorb

$$20 \times 0.24 \times 150 = 720 \textit{ B.t.u.}$$

for every pound of combustible. With 30 lb. of gas per pound of combustible the superheater will absorb

$$30 \times 0.24 \times 150 = 1080 \textit{ B.t.u.}$$

The resulting superheat will be in the proportion of 1440 to 2160, if the specific heat of superheated steam is 0.5. This means that every pound of combustible will deliver into the superheater, when 20 lb. of air is used, enough heat to superheat 100 lb. of steam 14.4 deg. F. When 30 lb. of air is used per pound of coal, the steam will be superheated 21.6 deg. F. It is useless to call attention to the fact that this is distribution of the heat and that final economy will be in favor of burning the fuel with 20 lb. of air. In practice the temperature of the gases entering the superheater is much higher than 600 deg. F., and this temperature is taken simply as an illustration. With higher temperatures such as are used in practice the emphasis in favor of more air per pound of fuel in the superheater will be still more striking.

With the amount of steam, temperature of gases and degree of superheat known, the pounds of gas can be found. With the temperature, quantity of gas and steam known, the superheat can be found. The rate of combustion and flow of steam being the same, the superheat will vary with the amount of gases per pound of fuel.

H. MISOSTOW.

Department of Smoke Inspection,
Chicago, Ill.

## Tilt Trap as a Boiler Feeder

Some interesting questions regarding that always important matter of the proper way to feed a boiler are brought up by Mr. Wickland's letter in the Sept. 24 issue.

Nowadays all uptodate plants have some arrangement for feeding hot water. Cold water not only causes injurious strains in the boiler tubes and shell, but usually contains a considerably larger amount of scale-forming matter and corrosive gases than hot water which has passed through an open heater.

The tilt trap, as Mr. Wickland says, is much like the injector in some ways. It will, however, operate with any temperature of the feed water, which cannot be said of the injector. The big disadvantage is that the feed is intermittent and the degree to which this is disadvantageous varies with the temperature of the water passing to the boiler. The temperature is never equal to that of the water in the boiler, with either an injector or tilt trap. With steam at 125 lb. gage the temperature is 353 deg. F. in the boiler. That the water coming from the trap would ever exceed 250 deg. F. is doubtful, and it is often much lower. Supposing the trap discharged 3 gal. of water at 250 deg., then

$$(353 - 250) \times (8 - \tfrac{1}{3} \times 3) = 2570 \textit{ B.t.u.}$$

is required instantly to heat this water to the boiling point in the boiler. This will cause the boiler to make less steam di-

rectly after the trap discharges than before. The evaporation will, therefore, be more or less intermittent, depending upon the temperature of the trap discharge, and the capacity of the trap as compared with the boiler rating.

What effect a large volume of comparatively cold water being suddenly admitted will have on the circulation will depend largely on conditions. In the modern return-tubular boilers the circulation is fairly rapid, particularly when they are developing their rated horsepower or more. Then it is doubtful if such intermittent injections would work appreciable harm. However, many boilers in use have a circulation that is anything but what it should be. A volume of water, much below the temperature of the boiling water would in such cases, particularly if injected through the blowoff connection or at a very low point in the drum, tend to "pocket," making the heat transmission at such points poor and consequently tending to overload the other parts of the boiler.

Another point must not be overlooked in considering this matter. The large volume of water, which as already pointed out is comparatively cold, even though above 212 deg. F., coming in contact with the shell and tubes, will cause local contraction, thereby setting up strains. There is thus the same fault as with cold-water feeding. This is a most dangerous evil, too, for it is something which we cannot see by trying the gage cocks or looking at the steam gage, and finally when the tube or shell gives way in the prime of life, as it were—even then we are apt to forget that cold-water strains have helped it along.

The question whether it is advisable to use live steam for heating water when exhaust steam can be had for the purpose has been answered so many times that the uptodate engineer says "No" even in his sleep. If exhaust steam is being wasted then the use of live steam, either by a tilt trap or injector, is certainly not advisable in any plant over 50 hp. in size having any pretensions to efficiency. The use of exhaust steam in this way is pure "velvet" and often goes far to make the purchase of a boiler-feed pump advisable to replace an injector or tilt trap in a plant where there is no other supply of exhaust steam.

A good open feed-water heater will receive the condensate and store it for boiler feeding, allowing the boiler-feed pump to take a continuous supply. Back pressure can be carried if desired, provided the heater has a float instead of a water seal, or the steam condensation can be returned to the heater through an ordinary steam trap. It seems as though the heater and feed-pump combination is worth the increased cost when we consider that the heater precipitates the temporary hardness, expels the air and other corrosive gases, and not only feeds a purer water, due to the condensation of the exhaust steam required to heat the water, but also employs a waste product instead of valuable live steam, thus adding to the steaming capacity of the boiler.

EDWARD H. ROBIE.

Philadelphia, Penn.

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Mr. Wickland raises the question as to the efficiency of a return trap as against a steam pump and compares its operation with that of an injector. An injector is capable of not only feeding water into a boiler but also of lifting it from below the boiler water line and in its operation the steam is mixed with the water and passes again into the boiler, acting as Mr. Wickland states, like a feed-water heater.

The operation of a return trap is entirely different and hardly admits of comparison with that of an injector. In the first place a return trap will not lift water from below the boiler water line and is only successful when placed at least 3 ft. above the water line. Two traps must, therefore, be used if the water is to be lifted, one to raise the water and the other to return it to the boiler. Secondly, the principle on which a return trap works is to have the water in the trap under the same pressure as the boiler and depend on gravity for feeding it into the boiler. This is accomplished by admitting steam into the bucket of the trap and the steam required is about three-quarters of the volume of the bucket for each dump, or approximately that of the water discharged. For 100 lb. pressure the weight of a cubic foot of steam is approximately 0.25 lb. while that of 1 cu.ft. of water is about 60 lb. Therefore, each 100 lb. of water will require about 0.4 lb. of steam.

If the steam pump is used each 100 lb. of water will require from 1½ to 2 lb. of steam, so that the amount necessary for a return trap is from one-third to one-fourth that for a pump. Moreover, with a return trap the heat in the steam is at all times returned to the boiler, while with a pump the conditions must be such that all the steam is used in heating the feed water so that a pump can equal in economy a return trap. This is a condition that is more rare than common. If two traps must be used the economy will be the same but the steam consumption would be double.

Added to the greater economy of a return trap the fact that it requires practically no attention or repairs makes it a highly desirable and economical means of feeding water to a boiler.

The last three questions asked by Mr. Wickland could only be answered after a long and elaborate series of experiments had been made, and which, up to the present time, I do not think has been done. In any event the effect of intermittent admission of feed water would be slight, so slight that it can be neglected as a factor in determining the economy between a return trap and a feed pump.

W. L. DURAND.

Brooklyn, N. Y.

## Systematic Note Keeping

Under this heading, Lloyd V. Beets wrote, in the Sept. 3 issue, of his method of recording those ideas and incidents which he later worked up into articles for the technical magazines, and asked for suggestions as to any improvements that could be made in it.

His method is certainly efficient and systematic, and the only criticism that could be made would be that it might be simpler and time and labor saved which is now used in copying the notes from the desk pad to the ledger. In my own work I always carry in my pocket a small loose-leaf book and, when anything worth recording happens, make notes in it. For a short article it is often only necessary to write a title at the head of the page with the assurance that, when it is desired to write on the subject, the title will be enough of a reminder around which to construct the article. For a longer article more notes and data may be placed on the same page under the heading. It may also be necessary to construct a skeleton for the article consisting of a number of subheadings arranged in the order that they would be written about. There is room for all of these things on the page and they can be altered or added to from time to time at any date between the beginning and completion of the article as the data is always at hand where it can be worked on during spare moments.

The heading and skeleton of the article gives an opportunity to write a rough draft of the entire article, during spare moments. Much of my work has been done while waiting for or traveling on cars, at lunch time, or during other short intervals that otherwise would have been wasted. When the article has been finished the notes in the loose-leaf book can be taken out and thrown away so that no dead matter is ever carried around, which would be the case with the ordinary type of notebook.

To keep a record of the articles between the time they are written and published, I find it best to typewrite them, making a carbon copy which is filed as a record until the article is published.

G. H. MCKELWAY.

Brooklyn, N. Y.

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The demand for tank steamers for transporting petroleum in bulk to Oriental countries is leading to the conversion of ordinary steamers into tank vessels. It is interesting to note that Hongkong shipyards are undertaking such work.

# Inquiries of General Interest

**Questions are not answered unless accompanied by the name and address of the inquirer. This page is for you when stuck—use it**

## *Steam for Oil Burners*

In using steam atomizers for burning fuel oil under boilers, what proportion of steam generated is required for operating the oil burners?

R. G. L.

From 2 to 10 per cent., depending on the type of burners employed and the skill in handling.

## *Pounding Check Valve*

How can the pounding noise of a check valve on the supply line to a house tank be prevented?

C. P.

Pounding of a check valve on the discharge line from a pump can usually be stopped by placing a good-sized air chamber in the line near the inlet to the check valve, and running the pump at a higher speed.

## *Advantages of Synchronous Booster Converter*

What are the advantages of a synchronous booster converter over a regulating pole or split-phase converter?

G. B.

The synchronous booster converter has a higher efficiency, especially at lower voltages, and better commutation, especially at maximum load and high voltage, besides being lighter in weight and occupying less floor space.

## *Utilizing Heat of Blowoff*

Can the heat contained in scum blowoff water be employed for heating fresh feed water in an ordinary closed heater to as high temperature as by use of exhaust steam?

F. P. K.

As a large part of the heat in exhaust steam is in the form of latent heat, exhaust steam used in a closed heater of proper proportions is capable of imparting practically the same temperature to feed water as the temperature of the steam itself. Blowoff water could not conveniently be employed before being reduced to atmospheric pressure and liberation of heat in excess of latent heat at 212 deg. F. The transfer of heat would necessarily be to a lower temperature of the feed water and the efficiency of the heating surface would rapidly become impaired by impurities contained in the blowoff water.

## *Vacuum Breaker on Open Heater*

Why is it necessary to use a vent pipe or vacuum breaker on an open feed-water heater?

C. G.

A vent pipe is employed to prevent accumulation of air or the formation of a vacuum within the heater. A vacuum is liable to occur when only a small amount of steam is discharged to the heater. A vacuum breaker is used between the engine cylinder and the heater to prevent water of the heater or condensation in the exhaust pipe from being carried into the engine cylinder should a partial vacuum be formed before the exhaust valves open, as result of early cutoff.

## *Loose Crankpin*

Can a good, safe job be done by riveting fast a crankpin on a 16x42-in. Corliss engine which has been run loose in the crank for several days?

T. E.

If the pin is simply loose without any appreciable variation from the size of the crankpin hole, a good job of riveting may answer for temporary use, but the repair should be regarded as temporary until replaced by a pin inserted with a press fit. If the hole is larger than the old pin, the former is probably worn out of round and reboring the crankpin hole as well as a new pin will be required as a permanent and safe repair.

## *Resistance of Stay Bolts*

What boiler pressure would be resisted with a factor of safety of 7 by standard V-threaded firebox stay-bolts ¾-in. outside diameter made of iron having a tensile strength of 42,000 lb. per sq.in. of cross-section, spaced 4¾x4¾-in. centers?

F. M.

The diameter of stay-bolts at the bottom of the thread would be 0.6057 in., and the area 0.288 sq.in., and the strength of each would be

$$42{,}000 \times 0.288 = 12{,}096 \text{ lb.}$$

hence the allowable strain per stay-bolt with a factor of safety of 7 would be

$$\frac{12{,}096}{7} = 1728 \text{ lb.}$$

Each stay-bolt would support

$$4\tfrac{3}{4} \times 4\tfrac{3}{4} = 22.5625 \text{ sq.in.}$$

therefore the allowable boiler pressure per square inch resisted by the stay-bolts would be

$$\frac{1728}{22.5625} = 76.58 \text{ lb. per sq.in.}$$

## *Drips of a Vacuum Heating System*

In a vacuum-exhaust steam-heating system, how can the drips of mains be connected to the returns so as not to sustain loss of steam or impair vacuum in the returns?

F. M. B.

A main drip should be sealed by running it so as to form a deep trap before discharging to the returns. The highest point of the trap so formed should be 20 to 30 in. lower than the connection to the steam main, and the deeper the trap the higher the vacuum may be carried before siphoning will take place.

## *False Admission Line on Diagram*

What defect in operation of an indicator would falsely produce resemblance to a perfect admission line, forming a sharp corner like a perfect cutoff where it intersects the expansion line of the diagram?

A. C.

If the pressure during admission is higher than the instrument can properly indicate, as might happen when using a spring which is too weak for indicating the initial pressure, or when the piston is prevented by dirt or other obstruction from carrying the pencil to the proper height for the scale of spring employed, then a false admission line will be drawn below the height of true admission pressure and it will be parallel with the atmospheric line, in that respect resembling a perfect admission line.

The diagram will present the appearance of a true diagram having its upper part removed by a straight line dropping by a sharp turn into the true expansion line after cutoff has actually occurred, and insinuate a sharpness of cutoff that would be impossible excepting by absolutely perfect cutoff mechanism.

# Study Questions

**This Week's Questions**
**Last Week's Answers**

(121) A storage battery consists of 25 cells arranged in series-multiple with five groups in parallel and five cells in series in each group. The electromotive force of each cell is 2 volts, and its internal resistance is 0.04 ohms. With an external resistance of 0.5 ohms, what current will pass through the circuit?

(122) An engine takes steam the full stroke and operates condensing. The admission pressure is 60 lb. abs., and the back pressure 2 lb. abs. Neglecting condensation, how much water must be evaporated for this engine per effective indicated horsepower per hour if the specific volume of steam at 60 lb. is 7.037 cu.ft.?

(123) A tank holds 100 gal. and has two discharge outlets, one discharging 14 gal. per min., and the other 9 gal. per min. Using the outlets one at a time, how long must each be open to empty the tank in exactly 10 min.?

(124) What is the content of a cylindrical air tank having two bumped heads (one convex and one concave) if the body is made from a sheet 6 ft. square, and all seams have 3-in. lap (neglecting thickness of the material)?

(125) A beam 24 ft. long has two supports, one at the right end and the other 4 ft. from the left end. What is the load on each support if the beam has a uniform load of 800 lb. per ft. of length, a concentrated load of 9000 lb. 8 ft. from the right support and one of 5000 lb. at the extreme left end.

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*Answers to the above will appear in the next issue. Answers to last week's questions follow:*

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(116) The part of the tank displaced by the wall corresponds to what is known in geometry as a cylindric ungula, and when the plane cutting off an ungula passes through the center of the base the volume of the ungula may be found by the formula

$$V = \tfrac{2}{3}\, r^2 h$$

where

$r$ = Radius of the base;
$h$ = Height of the ungula.

In the problem given $r = 6$ in. and $h = 9$ in. Then

$$V = \tfrac{2}{3} \times 6^2 \times 9 = 216 \textit{ cu.in.}$$

is the volume of the ungula. Had the cylinder been complete its volume would have been the area of the base times the height, or

$$3.1416 \times 6^2 \times 24 = 2714.34 \textit{ cu.in.}$$

The content of the tank, therefore, is

$$2714.34 - 216 = 2498.34 \textit{ cu.in.}$$

(117) Let $x$ = Price of the packing per pound. Then $\frac{3x}{2}$ was the change offered. The cost of the packing first cut would have been

$$\frac{3x}{2} + 10$$

and the cost of half of it

$$\frac{\frac{3x}{2} + 10}{2}$$

This would be 5c. less than the money first offered; hence

$$\frac{\frac{3x}{2} + 10}{2} = \frac{3x}{2} - 5$$

$$\frac{3x}{2} + 10 = 3x - 10$$

$$3x + 20 = 6x - 20$$

$$3x = 40$$

$x = 13\frac{1}{3}$c. = Price of the packing per pound.

(118) One pound of water raised from 50 to 75 deg. F. absorbs

$$75 - 50 = 25 \textit{ B.t.u.}$$

Then $5\frac{1}{2}$ lb. absorbs

$$25 \times 5.5 = 137.5 \textit{ B.t.u.}$$

1 *Heat unit* = 778 *ft.-lb.*

Then 137.5 B.t.u. corresponds to

$$137.5 \times 778 = 106{,}975 \textit{ ft.-lb.}$$

(119) At 60 deg. F. 1 cu.ft. of water weighs 62.37 lb. Then 2 gal. of water weighs

$$\frac{231 \times 2}{1728} \times 62.37 = 16.675 \textit{ lb.}$$

When its temperature is raised from 60 to 69 deg. F., or 9 deg., the heat it absorbs is

$$16.675 \times 9 = 150.075 \textit{ B.t.u.}$$

This, then, is the quantity of heat lost by the iron in cooling from its unknown temperature to 69 deg. F. The specific heat of cast iron being 0.13, it loses 0.13 B.t.u. in cooling 1 deg. Then

$$\frac{150.075}{0.13} = 1154.423 \textit{ deg. F.}$$

is the number of degrees the iron has decreased in temperature. Hence its original temperature was

$$69 + 1154.423 = 1223.423 \textit{ deg. F.}$$

(120) The friction $F$ can be found from the formula

$$F = fN$$

where

$f$ = Coefficient of friction = 0.06;
$N$ = Normal pressure, lb. = $10 \times 2000$ = 20,000 lb.

Then

$$F = 0.06 \times 20{,}000 = 1200 \textit{ lb.}$$

The distance through which it is acted against for one revolution of the shaft is the circumference of a circle of the mean radius, or

$$2\pi r = 2 \times 3.1416 \times 6 = 37.699 \textit{ in.}$$

In feet, this is

$$\frac{37.699}{12} = 3.14 \textit{ ft.}$$

The shaft making three revolutions every 2 sec. makes

$$\frac{3 \times 60}{2} = 90 \textit{ r.p.m.}$$

Then in a minute the distance through which friction is acted against is

$$90 \times 3.14 = 282.6 \textit{ ft.}$$

The friction being 1200 lb. the energy consumed in friction is

$$1200 \times 282.6 = 339{,}120 \textit{ ft.-lb.}$$

and the horsepower consumed in friction

$$\frac{339{,}120}{33{,}000} = 10.276 \textit{ hp.}$$

# NEW PUBLICATIONS

KNOTS, SPLICES AND ROPE WORK. By A. Hyatt Verrill. Published by the Norman W. Henley Publishing Co., 132 Nassau St., New York, N. Y. 1912. Size, 4½x6¾ in., 102 pages, illustrated. Price, 60c.

This book is written in a practical manner, giving complete and simple directions for making the most useful and ornamental knots in common use. In addition to the text matter there are 150 illustrations which show how each knot, tie and splice is formed and its appearance when finished. The chapters on splicing, pointing, seizing and serving make the volume very complete.

ENGINES AND BOILERS. By W. McQuade. Published by A. Wheaton & Co., Ltd., 143 Fore St., Exeter, England. 1909. Size, 5½x8½ in.; 87 pages; illustrated. Price, $1.50.

Although this volume is intended as a handbook for young engineers on the construction and working of steam, gas, oil and petrol engines and steam boilers, it deals with each subject in such a limited manner that no one subject is given the attention it deserves.

The illustrations do not typify modern construction as found in this country, many showing the design of engines now obsolete. Stationary and marine construction are treated irrespective of their application one with the other. The only subject treated at any length is that of slide-valve action. Nine pages have been devoted to boilers of various types, and very little has been said regarding any of them. In reality the volume is more in the nature of a very elementary introduction to the steam-engineering field.

AERIAL OR WIRE ROPE WAYS. By A. J. Wallis-Taylor. Published by Crosby, Lockwood & Son, 7 Stationers' Hall Court, Ludgate Hill, E. C. London, 1911. Size, 5½x9 in., 246 pages, illustrated. Price, $3, net.

This rewritten work contains parts of an original work now out of print, but revised and brought uptodate. More subject matter and illustrations have been added to the chapter devoted to the details of construction, electrically driven wire-rope ways and miscellaneous information.

Descriptions of a number of rope-way installations are described and illustrated which give a very comprehensive idea of the various uses to which aërial rope-

ways may be put, also installed and operated.

A particularly interesting chapter concerns coaling vessels at sea, in which a number of the plans that have been tried out are illustrated and explained. The volume treats on the method employed for hoisting and conveying both in this and foreign countries.

Much miscellaneous information is given for calculating the strain on the carrying rope; also hints as to the splic securing, preserving and care of wire ropes.

HIGH EFFICIENCY ELECTRICAL ILLUMINANTS AND ILLUMINATION. By Rollin W. Hutchinson, Jr. Published by John Wiley & Sons, New York; Chapman & Hall, Ltd., London. 278 pages; 147 illustrations. Cloth, $2.50 net.

This work gives a complete and comprehensive description of the principal types of modern electric lamps manufactured in this country and Europe together with a discussion of their various characteristics and uses. The text is written in a manner making it intelligible to the layman as well as to the engineer and designer. The author has not attempted to introduce exhaustive details, but has aimed to make his book a complete work of general reference.

In the first chapter, the theory of light and color is presented according to the latest authentic observations. The structure of the eye is described, together with the causes of the sensations it experiences from lights and colors of varying intensities. Color values of various sources of light are given as are also the comparative calorimeter readings.

A complete explanation of the methods and procedures followed in photometry is presented in the next chapter. Various leading types of photometers are described by diagrammatic illustrations. Definitions are also given of the various units of light measurement.

Mr. Hutchinson devotes the next chapter to a treatise on metallic filament and electrolytic incandescent lamps. A short general history of the evolution of these types is given, together with a discussion of the chemical and physical properties of the metals used, including the sources from which they are obtained. The various processes of filament manufacture are explained and a well illustrated description is given of the principal types of lamps using the filaments. An especially noteworthy feature of this chapter is the presentation of statistics. Among these is given the total cost of producing light with the lamps, at different voltages and at various power rates, together with figures showing the comparative cost of producing given amounts of light with carbon, gem, tantalum and tungsten lamps. First costs are considered at length as are also the courses followed by various companies in supplying the lamps to customers. The difficulties encountered in the manufacture and use of metallic filament lamps are enumerated and explained, together with the means used for obviating them.

A chapter is devoted to arc lamps, the author setting forth the main points in the design of the principal types, giving especial consideration to the flaming arc variety. By diagrammatical illustrations, the mechanisms are clearly explained.

Vapor lamps are next taken up, the Cooper-Hewitt, the Kuch quartz mercury vapor lamp and the Moore tube light being described in detail. Several photographs of actual installations of some of these lights are shown to illustrate their practical efficiency.

The author devotes the remainder of the book to discussing the fundamental principles involved in the efficient and economical illumination of interiors and streets. Throughout the work careful attention has been given to the presentation of the statistics most needed by the estimator and engineer, together with the uninvolved descriptions sought by the layman. For a general reference upon electric lamps and illumination, the book is commendable.

ELECTRIC CRANE CONSTRUCTION. By Claude W. Hill. Charles Griffin & Co., Ltd., London; J. B. Lippincott Co., Philadelphia. Cloth; 306 pages, 6x9 in. Over 366 illustrations; 23 tables. Price, $8.

The author of this work has made it primarily a book of reference for engineers rather than an elementary treatise for the general reader. The descriptions follow English practice almost entirely, the illustrations being taken from the products of English manufacture rather than from cranes in general. However, the portions of the book devoted to the methods of procedure for computing the dimensions of the various parts and for estimating upon the design and construction can be applied to general use.

The opening chapters are devoted to descriptions of the different types, each chapter dealing with one particular class. The headings, in order of presentation, are overhead cranes; locomotive and portable jib cranes; derrick cranes; transporters; shear legs; revolving cantilever cranes and cableways. In the consideration of each class, machines of various makes and capacities are described in logical order, numerous photographic and diagrammatical illustrations being presented, together with large plates taken from working drawings.

Proceeding to the calculations of the component parts and elements, the author first discusses the procedure used in computing the driving power required. The figures are based upon observations taken from actual service, hence are of practical value as well as theoretical. Several tables and curves present data useful for this branch of design.

Starting torque and acceleration are next considered followed by a chapter devoted to the design of crane structures. Formulas for the computation of the stresses and loads involved are derived mathematically and discussed, the methods used by leading authorities being presented and explained in due order. Struts and columns are first considered followed by a section devoted to girders. Numerous curve sheets and diagrammatical plates illustrate the text.

In the next two chapters dealing with machine design and brakes, the calculation of dimensions of shafting, bearings, pedestals, wheels and the component parts of brakes is explained, the illustrations showing the construction of various details.

The author begins the chapter on toothed gearing by explaining the application of the lever principle to gearing, force diagrams being used for clearness. He then discusses the determination of the proper size and shape of the teeth. The forms of teeth best suited for various conditions are shown and the reasons for their use are clearly presented. This chapter, while giving the detailed information required by the engineer, is also intelligible for the most part to the layman.

Hooks, lifting magnets, ropes and chains are next considered, a noteworthy feature in this connection being the presentation of several tables giving in systematic order, the various properties of chains and steel wire ropes necessary to the designer. Following three chapters are devoted to the electrical equipment, including the design of magnets, motors, controllers, etc. This portion is involved for the most part with mathematical derivations; hence is of more value to the engineer than to the general reader.

Concluding the work with a treatise on installations, the author gives general directions for the selection and use of the equipment under various conditions. A number of prominent installations now in service are described.

The text of the book, considered from an engineering standpoint, has been well prepared, careful attention having been given to detailed information required by the designer, the data needed by the estimator, the explanations of practical value to the construction engineer and the theory sought by the student. However, the author's copious use of large folded plates for illustrating is to be condemned rather than approved, in that the cumbersome bulk thus added is a decided detriment to ease and convenience in the use of the book. The plates could have been reduced and printed upon regular pages without materially affecting the purpose for which they were intended. Aside from this objectionable feature, the book ranks well as a work of reference for students and professional crane men.

## Smoke Abatement in Scotch Cities

The gas and electricity departments of Glasgow Corporation are competing in the exhibition of appliances for the reduction of smoke from furnaces and kitchen ranges. The electricity department has a complete electrically fitted restaurant, where cooking, kitchen work, cleaning, heating and lighting are effected by electric current.

The gas department has a "gas-equipped house," in which cooking and heating are done by gas fires, and all lighting is obtained from incandescent-gas burners of different types. The corporation is encouraging the reduction of smoke by holding these periodical exhibitions, and also lending gas cookers free, having loaned 37,000 since Mar. 1.

## Gas Engine Association Convention

The National Gas Engine Association will hold its annual meeting at the Claypool Hotel, Indianapolis, from Dec. 3 to 5. Among the papers to be read are: "Gas Engine Design," Prof. C. D. Wagner; "Gas Producer for Power and Foundry Service"; "Gas Engine Economy," A. E. Potter; "Two-cycle, Two-cylinder Opposed Engines," Ben Heer. There will be the usual exhibits of accessories, engine parts, etc., and space for exhibits may be had by applying to R. A. Oglesby, Hercules Electric Co., Indianapolis, or to Albert Strittmatter, secretary, 224 East Seventh Ave., Cincinnati, Ohio.

## New Plant in Service

The trial runs of the plant in Bamberger & Co.'s new department store at Newark, N. J., have been completed and the equipment is now carrying the daily load. This plant is one of the largest and most uptodate department-store plants in the East.

## Transfer of Atlas Works Completed

The transfer of the buildings of the old Atlas engine works, Indianapolis, Ind., to its new owners was made in Superior Court No. 4 of that city on Oct. 15. The consideration was $1,500,000.

The new concern will be known as the Lyons-Atlas Co. and its officers are: President, James W. Lyons; vice-president, William P. Lyons; secretary and treasurer, George Lyons. All are from Chicago. James W. Lyons was formerly with the Allis-Chalmers Co.

Attorney for the holders of patents were also present to protect the interests of their clients.

## Over the Spillway

**Just Jests, Jabs, Joshes and Jumbles**

Discarded hoisting rope is being converted into cigarette paper in Europe. First time we have been able to give that odor its proper designation. Thanks be, they can't utilize wire rope—yet!

Hall of Fame? Sure! E. D. Bangs sells cylinder oil for those bangs in your engine; H. L. Lapham, in setting his valves, will lap 'em; Smoke Inspector Oyster keeps mum, and writes what he has to say, and they can't distribute the current without Cable (J. A.).

Reuben, Reuben, I've bin thinkin'
What a glad world this will be
When them b'ilers cease their bustin'
And get safe for you an' me.

Laws don't seem to make us keerful,
Folks gits reckless jist ther same;
An' when we hev jined ther angels
Jury sez we was to blame!

HORAN—Th' ol' man sez that main damper nades renewin,' Terence.

DORAN—It's damper-tic'lar he's gettin' all to oncet.

Noted surgeon says that the heavier the service, the bigger the brain, and he has weighed up a three-pounder recently willed to him. Based on this theory, the twelve-hour, seven-day engineer ought to look like a dirigible balloon with feet under it; the service is heavy enough.

**"Liquor in the Cooler"—Headline.**

All right, R. M'Geddon, we have been battling some time to do just this thing, but the nearest we have yet come to "rich liquor" is that amber-hued stuff that's helped Milwaukee to enjoy more fame.

"A bed-cover and sheet wrecks a tandem-compound engine," says the *Travelers Standard*. In falling, they were drawn in the engine-room window by the revolving flywheel and lodged in the shaft governor. Safety engineers, take notice: there's a new hazard among you.

A millionaire, one Lemon (pronounced "Lay-mong" for a millionaire), is asked by the "Adriatic's" commander to "cease sending champagne and gold coins" to his stokers. Never mind, Cap, this proceeding will never become a habit. Most stokers (and editors) only know the lemon with the little "l."

## SOCIETY NOTES

On the invitation of the Commonwealth Edison Co., it was unanimously voted by the executive committee of the National Electric Light Association to hold the 1913 convention in Chicago.

At the annual meeting of the American Society of Mechanical Engineers, to be held in New York, Dec. 3 to 6, sessions will be given to the following subjects: Textiles, administration, cement manufacture, machine-shop practice and railroads. The Gas Power Section will also hold its usual meeting. On Wednesday evening, Dec. 4, the members of the society will tender a reception to Prof. John E. Sweet, honorary member and past president, who was one of the founders of the society, and who celebrated his ninetieth birthday Aug. 21 last.

Dean John Price Jackson, of the School of Engineering of the Pennsylvania State College, reports that the enrollment of freshmen in engineering numbers 354, the total enrollment of engineering students being 964. Prof. J. A. Moyer, recently of the University of Michigan, professor of mechanical engineering, is head of the department, and Prof. George W. Eckhard, recently professor of civil engineering at Milliken University, is assistant professor of structures.

## OBITUARY

William P. Abbey, former president of the Sunderland (Mass.) Electric Light & Power Co., died at his home in North Sunderland, Mass., on Oct. 5. Mr. Abbey was born in Sunderland on Aug. 1, 1876.

## PERSONAL

J. F. Nagle, for several years erecting engineer for the Allis-Chalmers Co. and the William Tod Co., of Youngstown, Ohio, and lately master mechanic of the New York, New Haven & Hartford R.R. power house at Cos-Cob, Conn., has been appointed superintendent of construction for the Boston Sanitary & Development Co., Boston, Mass.

Karl E. Eriksson, of Stockholm, Sweden, is in this country studying American practice in high-tension engineering. He is a graduate of the Royal Technical Institute of Stockholm and was an instructor in its department of electrical engineering for four years. He has been retained by the Swedish patent office as expert on electrical matters. Mr. Eriksson has conducted research work on high-tension phenomena and has written articles on protection of high-tension lines and other matters of a theoretical character, all of which have been published by the Swedish Technological Society.

# Moments with the Ad. Editor

One of the sights most interesting to the visitor to New York at present is the giant Woolworth building—the newest and highest of the sky-scrapers to lift its head above Manhattan's famous sky-line.

This building as everybody knows is the result of the success of the Woolworth 5 and 10 cent stores. Probably you have one of these stores in your own town.

The most remarkable thing about the whole thing is that back of it is the personality of one man—a man in no sense a genius, just an everyday, companionable, modest man, but one who was capable of seeing a big opportunity and of seizing it.

In a recent interview Mr. Woolworth talks of his early life:—

"There isn't much to tell. I stayed there until I was twenty-one, working in the fields in the summer, attending district school in the winter, and finishing off with a couple of terms in a business college in a neighboring town. I never liked farm life and always wanted to get into the dry goods line, so the first chance I got I took a job in Watertown, N. Y. I thought perhaps they'd give me a small salary to start with, but the head of the firm contended on the contrary that I ought to pay him tuition while I was 'learning the business,' so we split the difference and I worked three months for nothing. After that I received $3.00 a week with the promise of a semi-annual raise of 50 cents a week. At the age of 26 my income was $6.00 a week—hours 7 a. m. to 10 p. m.—and when my earning capacity reached $8.50 a week I married the little woman who has been my best friend for nearly forty years."

Nothing extraordinary about that, is there? But then Mr. Woolworth got the idea which was to make him rich and famous. He got the idea of establishing 5 and 10 cent stores. At first he was not successful but he stuck to it.

And to make a long story short, today the $13,500,000 Woolworth Building lifts its head to the clouds.

"Now, looking backward, Mr. Woolworth, what do you consider has been the secret of your success?" he was asked.

"First, because I gained a reputation of giving value for value," was one of the things he replied.

"Value for value" a simple phrase and yet consider all it means. No business can really grow big without it—no idea whatever its value can succeed without it. Bringing it right down to all of us, consider the advertisers who week after week tell about their products in Power to you, its readers. No force on earth could hold them in its columns issue after issue unless they gave "value for value."

Mr. Woolworth's career must be an inspiration to every red-blooded man living in this land of opportunity. It is a direct challenge to every such man to seize the opportunities around him.

The opportunity of the engineer is to equip his plant so that it attains the highest efficiency. And the products advertised in Power give him the means to do it.